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TABLE OF CONTENTS

LEADING ARTICLES: Page

A Unique Coal-Handling Plant for an Electric Power Station (illustrated).... 397
The Dissemination of Tuberculosis as Affected by Railway Travel; Dr. C. B. Dudley 399
The Missouri River Power House of the Metropolitan Street Railway Company, Kansas City, Mo. (illustrated); F. G. Cudworth..... 400
The New Philadelphia Building Regulations for Concrete Blocks..... 406
The Key West Extension of the Florida East Coast Railway (illustrated)..... 407
The Design, Construction, Efficiency and Maintenance of Signal Lamps..... 408
Municipal Improvements in Progress and Projected at Manila, P. I.; J. F. Case. 411
Sewage Contact Beds Declared Superseded by Percolating or Sprinkling Filters; Prof. Bostock Hill 411
Colloidal Matter in Sewage Effluents 412
High-Duty Cold Saw with Teeth of High-Speed Steel (illustrated)..... 412
Notes on Workmanship in Riveting (illustrated); A. J. Himes..... 415
The College Education of the Engineer; Wm. Kent..... 415

EDITORIAL ..... Page 413

Overcrowding of the Engineering Profession—Advance in Opportunity and Remuneration for Engineers—Demand and Supply in the Engineering Profession—Philadelphia Regulations for the Use of Concrete Blocks in Building Construction—Proposed Plumbing Code Requirements for Tile House Drains in Chicago—Are Sewage Contact Beds Dead?—Colloidal Matter in Sewage and Sewage Effluents—The Sewage Sludge Problem Not Solved—Water Supply and Sewage Disposal Inquiries, New York State—Municipal Work at Manila, P. I.

Tuberculosis and Car Sanitation 414

LETTERS TO THE EDITOR..... 415

Salt for Killing Weeds on Railway Track; G. H. Herrold—Loose Rivets in Structural Steel Work; Chas. C. Huribut, Gus. C. Henning, R. W. How—Notes and Queries.

ENGINEERING NEWS OF THE WEEK..... 419
PERSONALS 420
ENGINEERING SOCIETIES 420

A UNIQUE COAL-HANDLING PLANT FOR AN ELECTRIC POWER STATION.

The illustrations on this page and the one following show a coal-handling system recently installed at the power station of the Syracuse Lighting Co., Syracuse, N. Y., as an extension to a coal-handling and storage equipment which had come to be too small for the growing station. The new system, designed and built by the Robins Conveying Belt Co., of New York, is peculiar in its extreme flexibility, permitting the handling of coal in a number of ways by the same apparatus. It delivers coal to a large outside storage space and track of 80 ft. radius, which deposits the coal in storage either inside or outside of the fenced circle of the shovel track.

This shovel, of a capacity of 60 tons of coal per hour, was built by the Brown Hoisting Machinery Co., of Cleveland, O. The location of the storage yard necessitated the use of a crane suitable for traveling continually on a circular track, and owing to this requirement the trucks were made special, so that the crane would travel in its circular path without any undue cramping of the wheels. The gage of the track is 8 ft. The shovel is operated electrically, being driven by a single General Electric motor of 80 HP., wound for direct current of 500 volts. The motor is mounted

One of the many novel features in the design of this crane is the large gear for rotating. This gear is located directly above the main truck bed, and the upper surface of the gear is beveled, forming the track for the rotating rollers. This gear is not bolted to the truck bed on which it rests, but fits over a raised portion of the truck bed, which keeps the gear in the correct position with reference to the center pin or axis of rotation. The weight of the superstructure of the crane normally keeps this gear immovable, but if, due to a sudden jar, incidental to quick reversing of the direction of rotation, undue pressure should be brought against the gear teeth, this gear, not being bolted down, will slip sufficiently to re-

VIEW OF AUXILIARY COAL STORAGE AND HANDLING PLANT, SYRACUSE LIGHTING CO., SYRACUSE, N. Y.

a receiving railway-track, while in conjunction with the old installation it can take coal from the canal-barges by which part of the supply is received, and delivers to the overhead bunkers of the boiler-house. Coal can be transferred in any direction in this complete system.

Coal is received by rail on the coal track indicated in the general plan, Fig. 1, and is discharged from hopper-bottom or side-dump cars into a large track hopper situated beneath and to one side of the track. This hopper feeds a Robins belt conveyor 16 ins. in width by 82 ft. between centers of end pulleys (Conveyor A, Fig. 1), which, through a second belt conveyor (B) and the previously-existing scraper conveyor delivers the coal to the boiler-house bunkers. Coal is also drawn off from the track hopper by an electric locomotive shovel crane running on a circular upon a heavy casting at the rear of the turntable, acting as a counterweight to offset the tipping tendency due to the boom and bucket. The boom is of extra length, giving a working radius of 40 ft., with, at the same time, a considerable distance below the bucket to the ground level, permitting of ample height of storage. Special drum mechanism is provided for operating a two-rope grab bucket; this mechanism, including double drums with friction connection, clutches and brakes, enabling the operator to work the drums together or independently, as desired.

One man only is necessary to operate both the hoist and the bucket, this man being stationed on a raised platform in the operator's cab, having all the operating levers and controller handle within easy reach, the position of the levers being such that he at all times faces towards the boom.

lieve the impact and prevent any possibility of injury to the mechanism. The gear is a steel forging, the metal being the same as that used in the construction of locomotive tires. Another valuable feature is the way in which the rotating rollers in front of the rotating superstructure are carried. There are four of these rollers at this point, and each pair of rollers is carried in a steel-casting equalizer, set into the rotating casting. The use of the equalizing principle at this point has the result that each of the four rollers must necessarily carry its proportion of the weight.

Current is conveyed to the crane by two trolley wires carried on the fence posts of the inner fence. Suitable trolley poles with the base attached to the truck beam at the side of the crane, collect the current.

This crane has given the most satisfactory re-

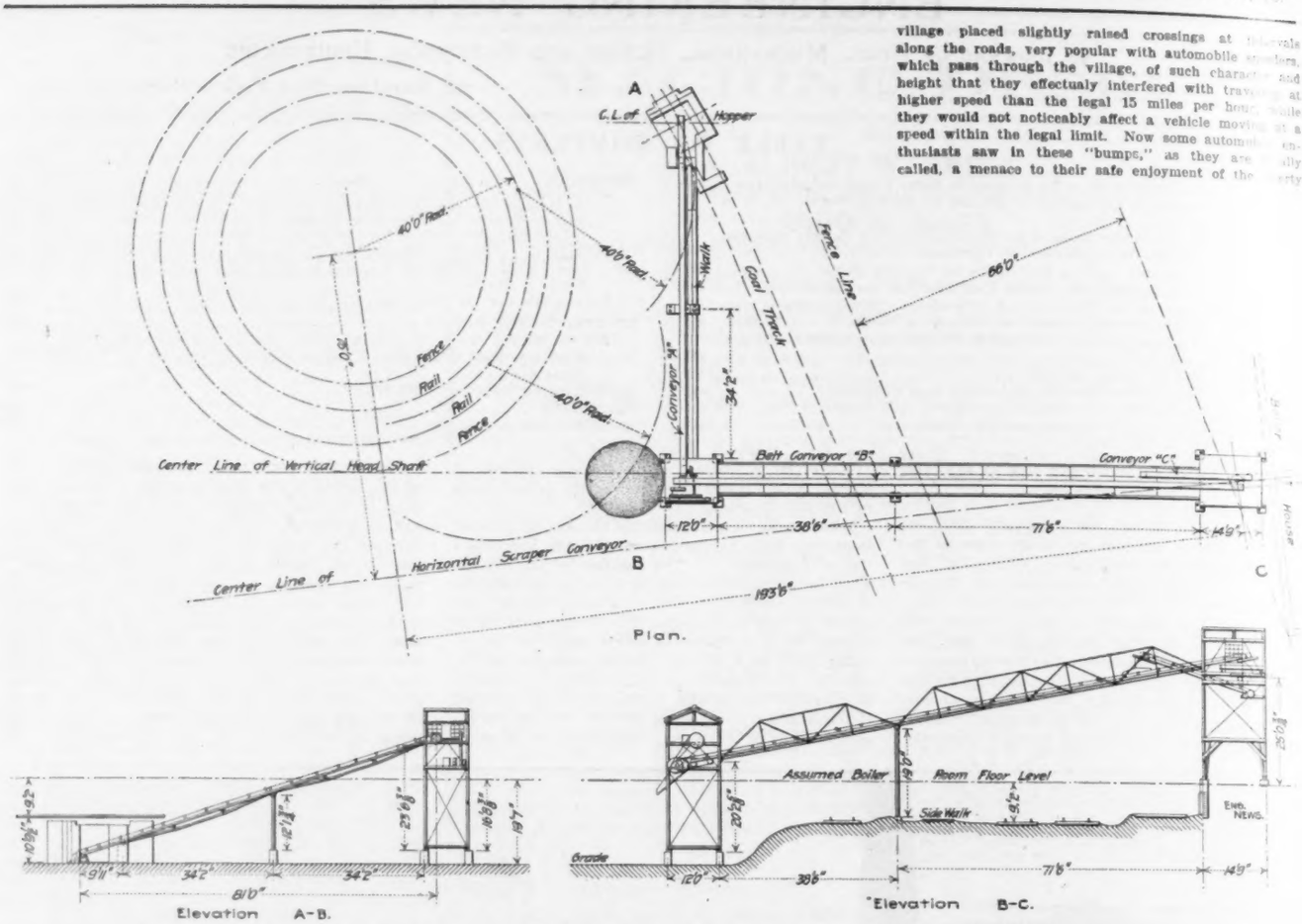

FIG. 1. GENERAL PLAN OF AUXILIARY COAL HANDLING PLANT, SYRACUSE LIGHTING CO.

sults since its installation. It has been in use now about one year.

When coal is to be taken from the receiving track hopper to the boilers, the belt conveyor "A" carries it from the track hopper, upward at an angle of about 18°, and delivers it to belt conveyor "B," at right angles to the first one. This conveyor crosses the railroad tracks between the storage and the power plant at an elevation of 25 ft.; it has an upward angle of 15°, and delivers the coal to the scraper conveyor, which discharges into the bunkers above the boilers in the power plant.

The scraper conveyor, installed some years before the belt conveyor system, had the original purpose only of carrying coal from barges on the canal, on the side of the station opposite the belt conveyors, to the boiler-house bunkers. When the power station required only a relatively small amount of coal, the scraper conveyor fulfilled all requirements. Since no provision was made, at the time of the original installation, for an auxiliary storage area in line with this conveyor, it became necessary when the plant increased in size to provide further storage and equipment, in order that there might be a reserve of coal above the capacity of the boiler-house bunkers. The belt conveyor installation solved this problem.

To transfer coal from barges or the boiler-house bunkers to the outside storage, a third belt conveyor (C, Fig. 1) is provided. This runs from a small hopper under the end of the scraper conveyor, and delivers on to the conveyor "B." The latter is reversible; when it delivers coal outward to storage, it dumps the coal in reach of the locomotive shovel (see Fig. 1). To return coal from the outside storage to the boiler-house, it is picked up by the shovel and dumped into the receiving track-hopper, whence it is removed by conveyor "A."

The two large belt conveyors, "A" and "B," are driven by a 10-HP. electric motor located at their junction. The small conveyor "C" is driven from the end shaft of the scraper conveyor.

The outside storage provided in this system has a capacity of 15,000 tons of slack coal. The belt conveyor system, running at a speed of 350 ft. per minute, can handle 55 tons per hour.

AN ANTI-SPEEDING DEVICE used on the streets of the village of Glencoe, Ill., a north Chicago suburb, was the subject of a legal decision in Chicago recently. The village placed slightly raised crossings at intervals along the roads, very popular with automobile speeders, which pass through the village, of such character and height that they effectualy interfered with travelling at higher speed than the legal 15 miles per hour, while they would not noticeably affect a vehicle moving at a speed within the legal limit. Now some automobile enthusiasts saw in these "bumps," as they are usually called, a menace to their safe enjoyment of the property guaranteed them by the Constitution, and they therefore brought mandamus proceedings to compel the village to remove the obstructive crossings. The court decided, on trial, that the speed ordinance of the village of Glencoe is legal, and that the obstructions are proper.

IRON ORE is to be mined under the sea, probably, by the Nova Scotia Steel Co., at Belle Isle. One tunnel is now only 100 ft. inland from the shore line and about 100 ft. below sea level, and there is every indication that the ore extends out under the ocean in large quantity.

FIG. 2. LOCOMOTIVE SHOVEL ON CIRCULAR TRACK; AUXILIARY COAL HANDLING PLANT OF SYRACUSE LIGHTING CO.

THE DISSEMINATION OF TUBERCULOSIS AS AFFECTED BY RAILWAY TRAVEL.*

By Dr. Charles B. Dudley.†

Not a few times during the past few years, and especially in this association, the railroads of the country have been called quite sharply to account for their shortcomings in sanitary matters. Both in papers prepared for the purpose, and in the discussions which have followed, the indifference, to use a mild word, of the railroads to the public health has been pointed out, and in some cases pictures of conditions have been drawn which have had a tendency to arouse in the minds of the traveling public a belief that the railroads were potent disseminators of disease. The lack of ventilation, the lack of cleanliness, the failure to provide spittoons, the disregard of proper precautions in the cleaning of cars, both en route and at terminals, the failure to disinfect, the use of upholstery and carved or molded surfaces, instead of plain, smooth ones, the color of the hangings and blankets in the sleeping cars, the failure to properly care for the bedding appliances in these same cars, the failure to properly regulate temperatures in inclement weather, the fact that people affected with a communicable disease may at times be on cars with healthy people, the use of water and ice that may be contaminated, the possible danger from the common drinking cup, and the scattering of excreta along the track, have all been pointed out, and sometimes in language not too courteous, as sanitary sins, for which the railroads were more or less responsible. Indeed it is, perhaps, not too much to say that many ordinarily well informed people, by virtue of this agitation, have been led to believe that to take a trip on a railroad car was equivalent to incurring a serious personal risk to their own individual health.

In view of this state of affairs, it has seemed wise to spend some little time during the past two years in trying to get as positive and definite information as possible as to how seriously these various lapses from good sanitary practices do actually threaten the public health. While other communicable diseases have not been ignored in these studies, and while considerable data and information have been accumulated in regard to several others, the principal study has concerned itself with tuberculosis and the dissemination of that disease as affected by railway travel. Tuberculosis being a very general term, it would perhaps be more correct to say that what will follow applies more definitely to that form of tuberculosis which affects the lungs and which is supposed to be disseminated by means of sputum.

It is obvious, we think, that the railroads can hardly in fairness be held responsible for the dissemination of a communicable disease, when such dissemination is a resultant of the meeting of the diseased with the healthy. This may not seem absolutely apparent at first sight. It may be thought and urged that the railroads have no right to expose their healthy passengers to danger of contracting disease from others, and that they should exclude from their cars all people affected with communicable diseases. Indeed such demands have been made upon the railroads.

It has been claimed that every person affected with certain diseases, for example, small pox, diphtheria, whooping cough, typhoid fever, consumption, etc., should not be allowed to travel in the cars on a railroad. But the unfairness of such a demand will, it is thought, be evident after a few moments consideration. While it is undoubted that the railroads have a right to, and for that matter do, exclude from their cars people known to have contagious diseases, such, for example, as small pox, it is entirely evident that the exercise of this right depends on correct diagnosis. To refuse transportation to a person or persons because they were suspected by the ticket agent or conductor of having a communicable disease might entail serious consequences. Railroads are common carriers, chartered under the laws of the various states, given under those charters certain extraordinary powers, and at the same time by virtue of those same charters required to perform certain public duties, prominent among which are the transportation of persons and property. It is not possible to refuse transportation except under certain well defined conditions, and since neither ticket agents nor conductors are, or can be from the nature of the case, physicians, it is difficult to see how, at least under present legislation, transportation is to be denied even to those who may be affected with communicable diseases. The proper remedy for the state of affairs described, if any remedy is possible, would seem to be in legislation, making it a crime for those affected with certain communicable diseases to ask for or accept transportation from common carriers.

To apply this reasoning to the subject in hand. It seems clear that if the tröpschen theory of the dissemination of tuberculosis, advocated by Flügge and his school, be accepted as the potent means of the spread of this dread disease, the railroads cannot fairly be regarded as responsible for its dissemination. This tröpschen theory, as is well known, considers the minute little droplets, or finely atomized portions of the sputum ejected during the act of coughing by a consumptive patient, which atomized material may be taken up by the healthy who are near the consumptive at the moment, as the principal cause at least, of the dissemination of the disease. In few words, according to this theory, personal contact or nearness to a consumptive during the act of coughing is the condition which most largely contributes to its dissemination among the healthy. As already stated, if this theory is correct, it is difficult to see how, under present conditions, the railroads can be held responsible for the spread of the disease.

But it is to be confessed that the tröpschen theory is not universally accepted. Indeed, if we read rightly, not finely divided fresh sputum, but pulverized dried sputum, floating in the air, is generally believed to be the most important means by which the disease is spread. The literature of hygiene is full of statements to this effect, and it is not necessary here to recapitulate them. If, now, pulverized dried sputum is as potent as is believed, then it will be urged, surely the railroads have important duties in the premises.

Taking up this view of the case, it may be permissible to say that the time and study we have been able to bestow on the subject lead to the view that the dangers from infection, due to this cause, have been very greatly magnified, and that so far as the railroads are concerned there is very little evidence that the time spent by the ordinary passenger on either day coach or sleeping car cuts any figure in the acquisition of this disease. The following points seem to us to have some weight in sustaining this view:

(1) It seems to be generally acknowledged that what is usually termed "prolonged exposure" is essential, as a general rule at least, for tubercular infection. It is hardly possible for one who is not a physician to go into details and expand a point of this kind, and it is probably sufficient to simply mention it. But even the longest railroad journey, in intimate relations with a consumptive, could hardly be regarded as meeting the requirements of prolonged exposure, as they are commonly understood by the profession.

(2) Tuberculous sputum is extremely difficult to dry. If we are right, ordinary exposure to air currents does not readily convert this material into a condition sufficiently dry so that it is easily pulverized. Moreover, in most of the experiments made to prove the virulance of dried sputum, the material was artificially dried, at higher temperatures than prevail in the places where sputum is usually deposited. Still further, if we are rightly informed, attempts to dry sputum for purposes of experiment either in the direct rays of the sun, or even in diffused sunlight, not infrequently result in sterilization of the material. It is not so easy to get virulent sputum dry enough to be readily converted into fine dust.

But again (3) even though the material has been sufficiently dried, it is extremely difficult to pulverize. The dried sputum is more or less tough, tenacious and glue like. It is well known that in laboratories where this material is being pulverized for purposes of experiment it is customary to put sand in the mortar, along with the dried sputum, to assist in reducing it to a fine state of division. Cornet, who has made many experiments with dried sputum and published a good deal on the subject, gives some testimony on this point, which is quite pertinent. He says:

> Any one who has himself tried to rub the well dried sputum into atoms and to pulverize it very finely will agree with me that it is no easy task to produce a really fine powder which remains suspended in the air for some time. The strong statements that have been made up to now, that one has only to rub with the foot on the dried sputum to raise immediately a cloud of dust of infectious germs, are absolutely false.

Still further (4) even sputum, which has been artificially dried, and is then beaten and rubbed up into a dust from the carpets on which it was, readily falls to the ground. The viscous material in which the tubercle bacilli are imbedded in sputum is relatively heavy, even when dried, and in a fine state of division. Heymann's experiments seem to indicate that with the possible exception of where the disease germs are attached to very minute fragments of cotton or linen fiber, the power of the pulverized sputum to remain floating in the air is very small. In almost every case, even where the attempt was purposely made by artificial means to cause the artificially dried material to float in the air, after ten minutes none remained suspended, and in some cases ten-minute experiments gave negative results.

Finally (5) it is hardly fair to ignore the effect of light and air upon the vitality of this form of disease germ. A couple of days of strong light, and four or five days of even diffused light, are believed to be sufficient to largely, at least, sterilize tuberculous sputum, and since a railroad coach, from its construction, being long and narrow, and largely windows, offers the best possible opportunities for the action of light and air, it would seem that the chances for the long continued vitality of these bacilli, about which so much has been said, would, in these vehicles, be very much diminished.

The experimental data on which the above statements in regard to the characteristics of tuberculous sputum are founded have all been examined in their original form as published. Most of the data will be found in the Zeitschrift für Hygiene. The best resumé of the subject in English with which we are conversant will be found in the little book, "The Prevention of Consumption," by Alfred Hillier, Secretary of the National Association for the Prevention of Consumption (London: Longmans, Green & Co.). Dr. Hillier gives quite a number of references to the original sources of the information which he communicates, and in view of this, it has not been thought wise to load this paper with references. The latest edition of "Bacteriology and the Public Health," by Geo. T. Newman (Philadelphia: P. Blakiston, Son & Co), may also be consulted with great advantage.

But there is another phase of this subject of the dissemination of tuberculosis by railway travel that will perhaps bear a few words. If railway coaches and sleeping cars are as much of a menace to the public health as we have been led to believe, would it not seem that this fact would appear in its influence on the health of those railroad employees who, from the nature of their occupation, spend quite a portion of their lives on these cars? In other words, if there is great danger of infection with tuberculosis by reason of the contaminated condition of passenger coaches and sleeping cars, ought we not to expect to find many cases of consumption among passenger train conductors, passenger brakemen, sleeping car conductors, and especially among sleeping car porters, who are supposed to be naturally predisposed to the disease, and who, from their occupation, spend more time in and are brought more intimately in contact with the supposedly dangerous bedding, hangings and dust arising from sleeping in these cars, than any other people? These questions being suggested, we immediately began to search for information that would, if possible, throw some light upon them, and enable answers to be given one way or the other. Fortunately we are not entirely without data.

It is perhaps well known that during the taking of the last U. S. Census (1900), in certain areas known technically as the "registration areas," data were obtained in regard to the number of deaths per 100,000 of population during the census year from consumption, and at the same time the occupation of those having passed away was given. Doctor George M. Sternberg, in his recent book, "Infection and Immunity," gives the following table showing these data:

Average Deaths from Tuberculosis for the Whole Registration Area, 187.3 per 100,000.

Bankers, brokers and officials of companies	92
Laundresses	94
Farmers and farm laborers	111.7
Clergymen	123.5
School teachers, female	126.0
School teachers, male	144.0
Railroad employees	129.8
Dressmakers and seamstresses	130.0
Policemen	136.7
Lawyers	139.9
Mill operators	144.0
Physicians	158.8
Gardiners and florists	186.6
Journalists	188.4
Carpenters	231
Masons	293
Bookkeepers and clerks	308
Painters and glaziers	319
Servants, female	319.7
Sailors and fishermen	333
Barbers	334.9
Cabinet makers	359
Laborers	370
Servants, male	430
Printers	435.9
Cigar makers	476
Marble and stone cutters	540

It will be noted that so far as these figures prove anything, railroad employees suffer quite considerably less from consumption than the average of the community, and indeed that they are only surpassed in immunity by five other callings, in a list of 27 occupations. On consulting the original data in the census reports, it was found that just exactly what is covered by the term "Railroad Employes" was not as definitely stated as could be desired, but in view of the fact that separate headings are given for officials of companies, for bookkeepers and clerks, for carpenters, masons, painters and glaziers, and cabinet makers, it seems perhaps fair to conclude that probably what are technically known in railroad language as "shopmen, clerks and officials," were excluded, leaving the train employes, both freight and passenger, and probably the track force to make up the bulk of those enumerated as railroad employees. Whatever the limitations of the term, it is evident that these data, as far as they go, do not indicate that railway travel, at least so far as it influences the health of the most exposed employees, is any serious factor in the spread of tuberculosis.

But again, official letters have been written to the Pullman Company, asking for any information that they might have on this problem. Unfortunately, the Pullman Company has no statistics, but it says in writing that it has a large number of conductors and porters whose time of service in its employ has been continuous for a number of years, and that it has never known of either a conductor or porter acquiring any disease on a car, except one case of small pox. Furthermore, per-

*A paper read at the Thirty-third Annual Meeting of the American Public Health Association, Boston, Sept. 27, 1905.

†Chemist of the Pennsylvania Railroad Company, Altoona, Pa.

social conversation with a number of the oldest conductors, many of whom have been personally known to the writer, for a number of years, and some of whom have been twenty years in continuous service, has failed to find one who has known of a porter who had consumption, even among those longest in the service. It should perhaps be confessed that this data is not as definite as could be desired, but does it not seem fair to conclude that if either coaches or sleeping cars were anything like as potent in disseminating the great "White Plague" as many would have us believe, it would be impossible that employees, who spend so large a portion of their lives on these cars, would apparently so completely escape it. In other words, if these cars are so great a source of danger it would seem almost incredible that there would not be enough of the employees taken with the disease, so that it would attract attention.

We fancy it will be urged, and, indeed, it has already been brought forward by some who maintain the view that railroad cars are a menace to the public health, that there is a very good reason why railroad employees do not acquire the disease on cars, and that is that these men are vigorous and robust, and well calculated to resist; that only such men can stand the hardships of railroad life. But it seems to us that this argument is a two-edged sword, which cuts both ways. It must be remembered that railway trainmen are, from the necessities of the case, subject to great irregularities in the taking of food and rest, are many times subject to long continued strains and exposure, with insufficient food, and that these things are believed to be among the most potent causes that favor the onslaught of that form of tuberculosis, known as consumption. Moreover, this view is confirmed by the records of the Pennsylvania Railroad Co.'s Relief Fund, which show that the freight conductors and brakemen are actually more subject to tuberculosis of the lungs than are passenger conductors and brakemen—it being well known that freight trainmen are more irregular in taking food and rest and subject to greater hardships than the corresponding passenger trainmen.

Perhaps the most definite statistical record we have on the probable danger of infection from railway cars may be drawn from the records of the Pennsylvania Railroad Co. Relief Fund, already referred to. This fund is, as is well known, a beneficiary organization, contributed to by both the employees and the company. It now numbers over 80,000 members. Its benefits consist principally in payments from the fund, known as "Sick Benefits," "Accident Benefits," and "Death Benefits." That is to say, if a member of the fund is disabled by sickness, he receives for a period of time from the fund weekly payments, the amount of the payments depending on his grade in the fund; if disabled by accident, a larger amount is paid, and at death a lump sum is paid his family or heirs. The organization of the fund involves a corps of surgeons, who examine and certify the applicants for benefits, and very full statistics are kept. The fund has now been in operation eighteen years, all employees who desired to join being taken in without physical examination at the start. Later, physical examination somewhat after the manner of insurance companies was made a pre-requisite of membership. The records now embrace over 350,000 cases of what is technically known as "Disablement," which means that the man is sufficiently unfit for active duty, so that he is entitled to benefits. These records have recently been carefully gone over, with the idea in mind of finding out what they show in regard to tuberculosis. The figures actually obtained are as follows:

	Per 100,000 per annum.
Average disablement from tubercular disease during the eighteen years of the records.....	230
Ditto for passenger conductors	330
Ditto for passenger brakemen	120
Ditto for freight conductors	400
Ditto for freight brakemen.....	170

It will be noted (1) that both passenger and freight conductors show a higher disablement rate than the average of the whole fund; (2) that both passenger and freight brakemen show a lower disablement rate than the average of the whole fund; (3) conductors, both passenger and freight, show a higher disablement rate than brakemen; (4) as has already been stated, the passenger conductors and brakemen show a lower disablement rate than the corresponding grade of employes in the freight service. It is believed that at least two of the above rather anomalous results are easily understood when it is known that both passenger and freight conductors are among the older employes and that probably most of them were taken into the fund at its inception, without physical examination. This will explain why the conductors show a higher disablement rate than the average especially when it is known that the growth of the fund has been much more rapid during the later than during its earlier years. The large accessions, during later years, of members who had passed a rigid physical examination have brought the general average down. Second, the brakeman, both passenger and freight, are very much younger than the conductors, and a very much larger number of them have passed the physical examination. They should, therefore, show a lower disablement rate than the older conductors. The main point, however, as applying to the possible dangerous condition of passenger cars in the matter of the dissemination of tuberculosis, is that the disablement of passenger conductors and brakemen is actually lower than that of the freight conductors and brakemen. If passenger cars are as dangerous as has been supposed, we would expect the reverse to be the case.

It may not be amiss to add that the records of the Pennsylvania Railroad Relief Fund show something also in regard to the death rate from tuberculosis of the employes we are studying. During the earlier years of the fund, many of the employees who developed tuberculosis, left the service and were lost sight of, so that the data of those years are imperfect and do not represent the facts. But during the last four years all cases have been covered, and the figures show as follows:

	Per 100,000 per annum.
The death rate from tuberculosis of all members of the fund has been	90
Ditto for passenger conductors	77
Ditto for passenger brakemen	52
Ditto for freight conductors	100
Ditto for freight brakemen	67

Here, again, as in the previous case, the danger of tuberculosis, as measured by the death rate, is less for the passenger trainmen than for the freight trainmen, and in this case the passenger trainmen, both conductors and brakemen, show a lower death rate than the average of the whole fund. We think it is fair to say that the value of figures of this kind is the greater the more carefully they are kept and the longer the period of time which they cover, but it is certainly difficult to draw from these figures anything that indicates that passenger cars are a serious source of danger to the public health, so far as tuberculosis is concerned.

So much space has already been taken by what has preceded that it is only possible to refer briefly to the extremely valuable paper by Dr. J. J. Kinyoun, of Glenolden, Pa., on "The Bacterial Content of the Railway Coach." We wish it were possible to present here a full abstract of that paper. It is apparently the first real careful work done, at least in this country, in trying to get positive knowledge of the actual conditions of railroad coaches and sleeping cars, as to their liability to disseminate disease. There is, however, less occasion for regret that we are able to say so little about that paper, since it was published in full in the "Medical News" of New York for July 29, 1905. We may, however, mention that out of 14 examinations of carpet dust from cars, many of which were known to have carried tuberculous people, none showed the presence of the tubercule bacillus; out of 64 examinations of dust collected by means of swabs from the interior surfaces of similar cars, including seats, bedding, curtains and woodwork, only one showed bacillus tuberculosis, and this was doubtful; out of 96 examinations of air from similar cars, only one showed bacillus tuberculosis; and out of 21 bacterial examinations of material obtained from drinking cups, none showed this same bacillus. Doctor Kinyoun is very modest in his paper, and calls for more work along this line; but we cannot help feeling that a careful perusal of his paper will give very little comfort to those who think that sleeping cars, even those engaged in transporting tuberculous people to sanitary resorts, are a serious element in the spread of the disease.

This brings us, in conclusion, to a few experiments of our own which have given results so contrary to the teachings which at present prevail in regard to their subject matter that we almost hesitate to bring them forward. After quite a little thought we have, however, concluded to do so, with the hope that others will repeat them, and either show where we are wrong, or confirm our data, and thus help to modify the present trend of hygienic teachings upon this matter.

It is well known that there has been and apparently is now a general belief among sanitarians that the upholstery of passenger coaches and sleeping cars is a serious menace. The outcry against upholstery has embraced the hangings, the carpets and the plush coverings for seats and the blankets in sleeping cars, and the plush on the seats, and the carpets or mattings in the aisles of passenger coaches. The philosophy of this outcry seems to be that smooth, hard surfaces are easily cleaned, while upholstery of all kinds is not easily cleaned and may serve to retain tuberculous sputum as a constant menace to those who are brought in contact with it. On the other hand, it occurred to us that plush, carpet and the various upholstery in use in passenger and sleeping cars might retain the infectious material much better than a bare, smooth surface, and that there might be less danger both of the material becoming dried and of its being stirred up into the air from a carpet or from upholstery than if smooth, hard surfaces only were present.

In order not to have this matter wholly a question of opinion, the following experiments were carried out. The resources of our bacteriological laboratory not enabling us to experiment with tuberculous sputum some flour paste of about the thickness of tuberculous sputum was made, putting into the paste a certain amount of common salt in order to have in it something which was measurable. This paste was put in equal amounts on (1) pieces of glass; (2) pieces of carpet; (3) pieces of plush. The three series of objects were then allowed to dry in the air. It was found that the paste on the glass dried more readily than on the plush or the carpet, which is what would be expected from previous experience with the hygroscopic nature of fabrics. The drying in the air was so slow, however, that ultimately all the pieces were dried artificially over the steam table. After they were thoroughly dried, a heavy iron roller was passed over each one of them the same number of times, the idea being to similate the conditions of grinding tuberculous sputum under the foot. Some of the pieces were then put in the window to be subjected to the wind, so that it might blow away as much of the material as it would, and some were put in a box and blown upon with compressed air. The three kinds of samples were treated exactly alike in all of the experiments. After the pulverized material that it was possible to remove by the compressed air had been blown away each of the three kinds of articles was carefully washed, and the amount of material left behind in each case, as measured by the salt, determined. The average of a number of experiments showed as follows: On the glass 61% of the paste had been blown away, while on the plush and on the carpet, only 12.50% had been blown away. These figures can be stated in another form. On the glass over one-third of the material staid behind, while on the plush and on the carpet, seven-eighths of it staid behind.

We cannot help feeling that these experiments point very clearly in the direction that the danger of infection from upholstery in Pullman cars and coaches is very much less than from naked surfaces, and that the crusade against hangings and carpets and plush is not founded on careful experimental data.

It gives me great pleasure to express my indebtedness to Mr. M. E. McDonnell, Bacteriologist of the Pennsylvania Railroad Co., for assistance in preparing this paper.

THE MISSOURI RIVER POWERHOUSE OF THE METROPOLITAN STREET RAILWAY COMPANY, KANSAS CITY, MISSOURI.

By F. G. Cudworth,* Assoc. M. Am. Soc. C. E.

During the past three years the old dilapidated cable roads of Kansas City have been replaced by electric lines, old plants have been torn down and new ones built, grades re-established and cars re-routed, until the old resident no longer recognizes the transportation facilities of his native town. No one change has been more important, or its effect upon the transportation features of the city more marked, than the building by the Metropolitan Street Railway Co. of its mammoth 40,000 K.W. station at First St. and Grand Ave., known as the Missouri River Powerhouse, described in the following article.

The final plans for the building and the selection of the site were not definitely decided until late in 1902, at which time a combination of both lighting and railway interests was perfected, and a complete reorganization and change of engineers was made. This in itself necessitated some delay, and actual construction work on the excavation of the site was not started until about September, 1902.

LOCATION AND EXCAVATION.—The site selected for the new powerhouse was about 1,000 ft. from the Missouri River, between the tracks of the Chicago & Alton Ry on the north and the Kansas City Southern Ry. on the south, with a difference in elevation between the two of some 26 ft. This fact was taken advantage of in building the station and in arranging for coal supply, etc. Fig. 1 shows a general plan of the site with reference to the location of building and tracks.

The contour of this location was very sharp. Grand Avenue, the only street cut through to the north and south, was the street used for all the large freight shipments of both the Missouri Pacific and Chicago & Alton Rys. On the east, Locust St. consisted of a bluff about 75 ft. high, while the land adjacent to Grand Ave. was covered with negro huts and sloped back to the bluffs on the south and east. Underlying this bank, which consisted of a stiff clay locally called "gumbo" which has the property of standing nearly vertically without sliding, is a layer of stratified rock of an argillaceous character, and at this spot, having practically no dip, it lies at an elevation of 17 ft., city datum.

In excavating, advantage was taken of local conditions, and by the aid of a large city sewer which cut diagonally across the northwest corner of the site nearly all of this immense quantity of earth was excavated by the hydraulic method and washed through the sewer into the river.

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Connection was made on the Second St. bluff with a 12-in. city water main, a 10-in. branch pipe running parallel with the station being taken off the main, and six branches off this 10-in. pipe leading to hose connections at different points of the site. To these branches were attached lines of heavy rubber hose. Streams of water, backed by the city pressure of some 110 lbs. per sq. in., were directed against the banks of clay. These streams played havoc with the clay banks, rapidly washing them into the sewer, and through this to the river, some 1,000 ft. away. Fig. 2 is a view of the site during the progress of this work.

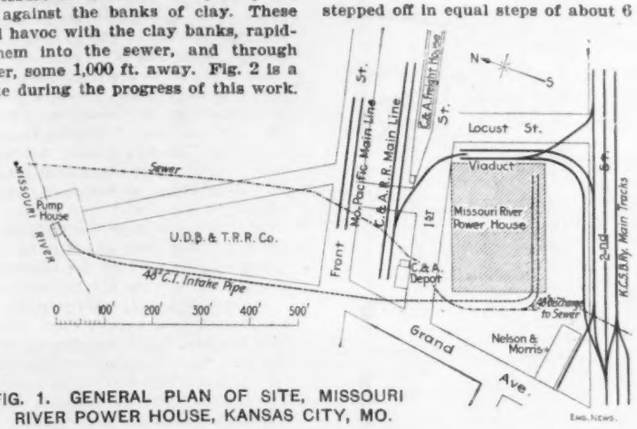


FIG. 1. GENERAL PLAN OF SITE, MISSOURI RIVER POWER HOUSE, KANSAS CITY, MO.

A temporary pumping plant was established at the site, which discharged into a pipe line leading into the sewer. Teams and shovelers were also used, to cart the earth from that portion of the site farthest from the sewer. This earth was hauled about 1,200 ft. and deposited along the river bank, and aided materially in forming a fill which later proved to be the only land above the elevation of the great flood of June, 1903.

Some 175,000 cu. yds. of clay was in this way rapidly excavated and washed into the river. Bed rock was reached early in November, 1902, and it was decided to excavate 2 ft. of this, not only to assure firm rock, but also to supply stone for crushing for concrete. Numerous pockets were found in the formation, many of which had to be excavated several feet deep and filled with concrete. Considerable difficulty was found in building the footings for the Locust St. retaining wall, owing to the presence of numerous springs at the foot of the bluff. As soon as the clay was saturated with water it was very little better than quicksand.

GENERAL DESIGN.—The new interests that obtained control of the railway and lighting properties of the two Kansas Cities, and their engineers, Ford, Bacon & Davis, of New York City, found themselves somewhat handicapped by the former engineers, inasmuch as one-half of the equipment for the new power station had been ordered and work on the engines was well under way at the time of their taking hold of the properties. The rapid forging to the front of the steam turbine, and its promise of becoming a successful competitor of the reciprocating engine, made it imperative that this form of prime mover be considered. The subsequent design of the station was carried out with the object of making all additional installations turbine units. This changed the original plans somewhat, especially the electrical control devices.

As will be noticed in Fig. 1, the building occupies an irregular tract, and at only one point, the extreme northeast corner, does the building actually stand on the street line. The building is 265 ft. 9 ins. long by 195 ft. 4 ins. wide, with an extension on the east end 43 ft. wide which carries the structure out to the west building line of Locust St., and was originally intended for a pump-room, with the north end occupied by the coal crushers and conveying machinery. The east or outside wall of this extension is of very heavy concrete without any steel reinforcement whatever, (it is 9 ft. 6 ins. thick at the bottom, 4 ft thick at the top, and 41 ft. high at its highest point) and has no provision for expansion or contraction. It is one of the longest and heaviest pieces of monolithic concrete construction built in which there is no reinforcement or provision made for expansion. It has now been in position for two years and has no cracks whatever, and in addition to its original duty as a retaining wall it is now carrying a double-deck steel viaduct and tracks for coal cars.

The concrete work of the entire station is very extensive, as the two lower stories are entirely of concrete. The concrete walls are 5 ft. 6 ins. thick at the base (Elev. + 17) and run to Elev. + 42, or a total height of 25 ft., finishing at this elevation at a thickness of 3 ft. 6 ins., being stepped off in equal steps of about 6 ft. in height. No provision is made for waterproofing this wall, the concrete alone being relied upon to stop all seepage, and it has been found by actual experience to be sufficient. At times the water has stood nearly to Elev. + 35 on the outside of this wall, with the result that the only seepage was at spots where the forms had been wired through the concrete and the water followed the wires through the walls; in fact, holes were drilled through these walls in the basement to allow the surface water that had collected along the south side of the building to find its way into the surface drains and the hot-well within the station. At the time of the great flood of June, 1903, the water found its way into the station and rose to Elev. + 27½ through two 48-in. openings left in the concrete walls for condenser water pipes.

The building proper is a modern steel skeleton structure with hard-pressed brick exterior walls trimmed with Carthage sandstone. It is built entirely of fireproof materials, with floors and coal pockets of reinforced concrete. There are some 3,600 tons of structural steel in the main building. As an example of rapid erection this piece of work is well in the front rank, the first bay of boiler room steel being erected on March 16, 1903, and the last piece of engine room monitor placed in position on May 15, 60 days from the start. The contractors, the Illinois Steel Co., were under a penalty contract to have the building ready to start the brickwork within 90 days from date of their contract, and incidentally they were to receive $1,000 per day for each day they were ahead of that time; in this case, they succeeded in winning some $29,000, finishing their contract and getting tools and plant off the work a week before the great flood of June, 1903, which tied up all the construction work for over two months and cost the street railway company in the neighborhood of $500,000.

The station is divided into two parts by a heavy longitudinal fire wall near the middle line, forming an engine room 98 ft. 8 ins. wide on the south side. This room is commanded by a 60-ton traveling crane supported on intermediate columns, and having a clear span of 70 ft. 5 ins.; these columns help support the galleries which run the entire length of the building on both sides of the engine room and also across the east end.

Up to Elev. + 42, the level of the main engine room floor, the entire building is of concrete, the walls finishing off at that level to receive the brickwork. All concrete is of 1:3:5 proportions; Atlas Portland cement was used throughout. The contract called for machine-mixed concrete, and the contractors' plant consisted of two Smith mixers, with engines, etc. Most of the concrete was handled on wheelbarrow runs, although the concrete for the engine beds above Elev. + 29 was hoisted by machine. The entire floor system throughout the building is of reinforced concrete carried on steel beams, and has a cement floor finish.

Stairs in the east and west ends of the engine room, near the fire wall separating engine and boiler rooms, lead to the galleries and to the boiler rooms. The stairs at the west lead directly from the main entrance loggia, at engine room floor level (Elev. + 42), to the switchboard gallery (Elev. + 65). The stairs at the east end lead upward to the boiler rooms and crane runways, and down to the basement. Stairs are also located in the center of the building, leading from the main engine room floor to the lower boiler room at Elev. + 29.

Doors through the firewall at Elev. + 29, + 42, and + 65, lead to the boiler rooms. They are self-closing firedoors, hung on roller bearings and arranged to close by rise in temperature melting a composition link incorporated in the weight cord.

FIG. 2. VIEW OF SITE DURING PROGRESS OF HYDRAULIC EXCAVATION.

In addition to the 60-ton crane commanding the engine room, there are two 10-ton hoists for permanent service. One of these is located in the east doorway of the engine room, spanning the Chicago & Alton switch tracks, by which crane material is taken direct from cars and landed under the 60-ton traveler, which transports it to any part of the engine room. The other 10-ton crane is similarly located in the east doorway of the boiler room, and is used to handle material from cars to the lower floor of the boiler house.

The engine room is lighted by a monitor skylight running the entire length of the roof, and by two rows of large windows in the exterior walls. The skylight has some 5,000 sq. ft. of wire glass.

Figs. 3 and 4, showing respectively a cross section of the building and a longitudinal section through the engine room, will enable the general features of the construction and arrangement of the station to be understood. The method of erecting the engine room trusses is shown by Fig. 5, and the completed building by Fig 6.

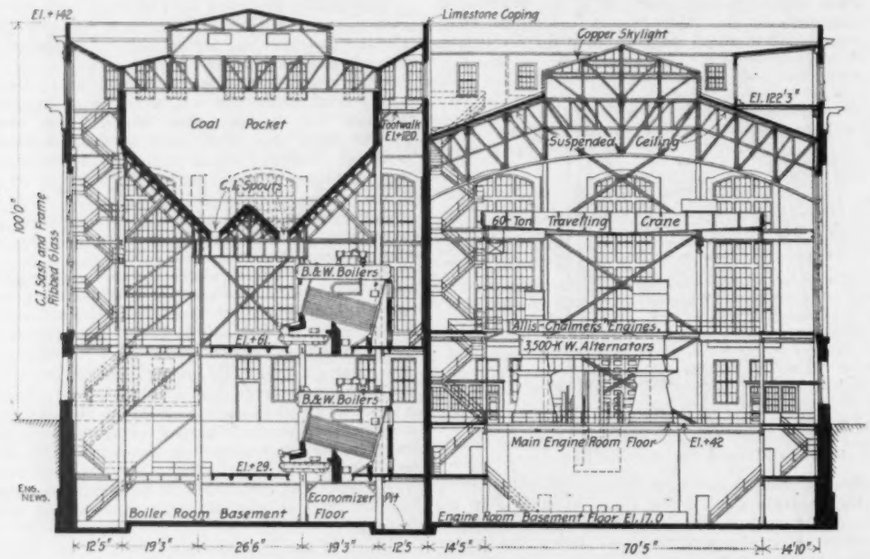


FIG. 3. CROSS-SECTION OF MISSOURI RIVER POWER HOUSE.

The engine room galleries are utilized for accommodating various auxiliaries and apparatus, as follows:

(a) Elev. +29. North side gallery is used as bus-bar gallery, and contains the concrete bus-bar compartments and the concrete barriers for the potential transformers. East end gallery contains private offices and bath-rooms for the engineer and the electrician, a lavatory and locker-room for engineers and oilers. Also at this level, along the south wall of the building, is located the atmospheric exhaust pipe, which at present runs half the length of the building but will be extended to the west as new engine-units are added; it discharges in the southeast corner of the building into a vertical 48-in. riveted steel pipe terminating in a Sterling exhaust head on the roof.

(b) Elev. +42; level of engine-room floor. A gallery along south end carries the switchboard which controls the storage battery supplying the exciting current for the generator fields. In the east end, on the main engine room floor, are two small offices, one in each corner, for operating engineer and electrician respectively. These offices are constructed entirely of fireproof materials, the walls being of cement mortar on wire lathing placed on angle-iron studding, while the windows and doors are of metal.

(c) Elev. 65. At the north side is the main steampipe gallery, which also carries the main switchboard and operating panel, the latter in a balcony 37 ft. long by 3½ ft. wide projecting from the center of the gallery. This balcony is on a level with the upper platform of the engines. The original design did not contemplate any passage between the two, but the railings have been cut and a bridge thrown across to permit of free passage from engine to gallery, which is proving to be a great convenience in operation. On the south side is a gallery which still remains without special use, but when the entire equipment is completed it will serve for a switchboard and steam-pipe gallery as does that on the north side.

Some other miscellaneous machinery and apparatus is located in portions of the basement. Underneath the north end gallery is an oil room, containing oil filters, pumps and pressure-tanks. The oiling system comprises a double line of pipe to both high and low pressure cylinders, two filters of a capacity of 600 gallons per day and a storage capacity of 250 gallons each, a 500-gallon storage tank, and a cylinder-oil tank of 150 gallons. The pumps are duplicates, each 4½ × 2¾ × 4 ins., of duplex type. Pressure is furnished to the cylinders and the bearings, different oils being used for the two. A Westinghouse locomotive air compressor is also placed in the oil room; air from it is piped to convenient points near engines and generators, switchboard, also to the boiler rooms, to the coal tower and to the pump pits, where suitable hose connections are made for clearing away dust and dirt by air blast.

The central part of the basement is used as a general store-room for material of all classes.

At the south end, extending for 15 ft. along the south wall, is a battery room containing 78 cells. This battery, which supplies the current for exciting the generator fields, was installed by the Electric Storage Battery Co. of Philadelphia, Pa. It has a capacity of 480 amperes for one hour when fully charged, at a temperature of 70° F. and a pressure of 125 volts.

The main condensers are also located in the engine room basement; they are described further on. Their 48-in. intake and discharge pipes extend along the south wall, on the basement floor. As previously noted, the atmospheric exhaust pipe lies above the condenser circulating pipes, at the level of the first gallery (Elev. +29).

BOILER EQUIPMENT.—The boilers are arranged in two decks, facing a central aisle or passage-way. There are twenty boilers on each floor, ten facing to either side. They are of the Babcock & Wilcox water-tube type, of 578-HP. rated capacity, arranged for superheating, and are set singly, with doors to the firebox on each side of the setting. This arrangement of boilers is a little unusual in recent power plants, but in the present case it was somewhat of a necessity as the building construction required to support the extensive coal storage bins would not permit of placing the boilers in batteries. In the center of the boiler room, and directly between the stacks, is a central light shaft running from the basement to the boiler room monitor and covered with a heavy wire glass and copper skylight. Stairs lead from the first boiler room floor to the basement through this shaft, and allow of

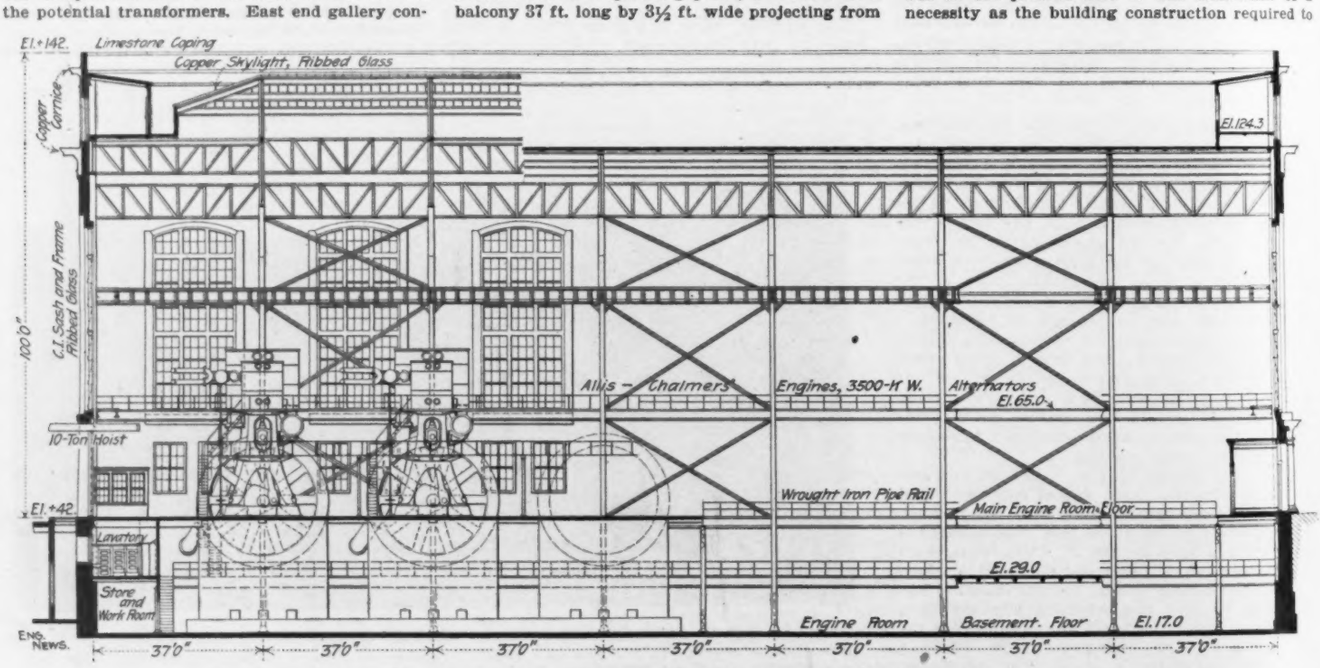


FIG. 4. LONGITUDINAL SECTION THROUGH ENGINE ROOM.

ready access to the boiler feed pumps and hot well, conveyor machinery, etc.

The general arrangement of the boiler house is as follows:

The basement is at Elev. + 17 ft., which contains the economizer pits which are excavated to Elev. + 15 ft., through solid rock. These pits are in the rear of each row of ash hoppers or along the exterior walls of the boiler room; they are connected by a series of drains with the sump well, which is also excavated in rock to a depth of 9 ft. below the basement floor, is located to the west of the stacks and takes care of the surface drainage of both engine and boiler room basements. The economizers have not as yet been installed. Midway of the east half of the boiler room basement is excavated, also in rock, the hot well, 10 ft. × 25 ft. long × 12 ft. wide, which receives the water of condensation as it comes from the condenser in the engine room basement. This water is brought to the hot well through a line of wrought iron and cast iron piping. In the engine room basement these pipes rest on the basement floor until they reach a point near the northwest corner of the bed of Engine No. 1, (the one nearest to the Locust Street side of the building) where they are deflected into a trench excavated through rock and covered with a corrugated iron floor plate. This trench contains the 20-in. cast iron pipe and runs direct to the hot well. All of these trenches and wells were cut out with a channeling machine and are left as they were excavated through the rock, no concrete being used in shaping them up, except that necessary to level off the bottom of the trench. All drainage brought to the hot well is clear water and is used in feeding the boilers. Another shallow trench, also cut with the channeling machine through solid rock, runs through the center of the basement, connecting with a cross trench just west of the stacks, which leads into the sump well. In this latter is collected all of the station drainage; it is emptied by a steam bilge pump 6x12x10 ins., of the vertical automatic type, discharging into the city sewer.

In the southeast corner of the boiler room is a passenger elevator, an electrical machine operated from any floor or from the car, by means of an operating cable. It was installed by the Moline Elevator Co. of Moline, Ill. It commands all of the boiler room floors except the basement, also the landing at the extreme top of the coal pockets. In the center of the boiler room and also at the east end is an electric freight hoist, installed by the same company, which runs from the basement to the upper boiler room floor. This hoist is capable of raising a load of 3,000 lbs., and proves very useful in handling oil and coal and light pieces of machinery. In the northeast corner is a stairway leading from the basement to the roof and coal tower walk, this latter being a concrete slab, running the entire length of the pockets at an elevation of + 120 ft. 2½ ins. At each end of this walk are stairs leading to the walk above the coal pockets and running along side the conveyor at Elev. + 132 ft. At the east end this walk leads to the conveyor tower and gives access to the conveyor motor and rheostat.

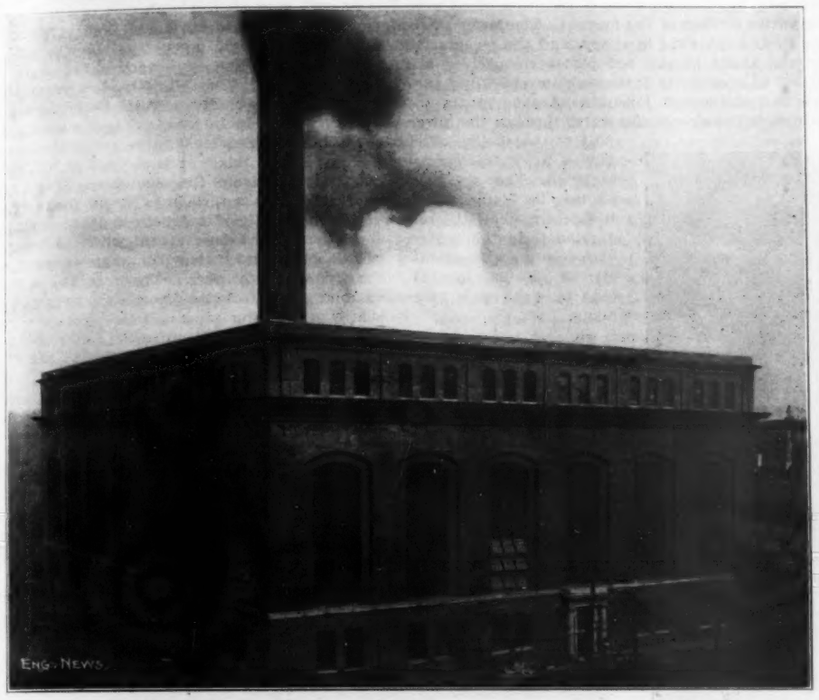


FIG. 5. VIEW OF COMPLETED BUILDING, MISSOURI RIVER POWER HOUSE, KANSAS CITY, MO.

COAL AND ASH HANDLING MACHINERY.—Coal and ashes are handled by means of a McCaustin bucket conveyor, which travels the entire length of the station, rising at the east end in a separate conveyor tower to the height of the boiler room monitor where it enters the building traveling the entire length of the same and drops to the basement. Coal is received on the east end of the station where provision is made to unload from both the tracks of the Chicago & Alton Ry. at Elev. + 42 and the Kansas City Southern at Elev. + 65; loaded cars are run in on a double deck trestle and unloaded from both tracks at the same time. The coal is discharged into a large receiving hopper having a capacity of some four cars, from which it passes through a crusher, and as it leaves this is picked up by the conveyor buckets and carried to the roof and along the pockets wherever required. Storage capacity is provided for some 12,000 tons. The pockets are constructed of concrete resting on steel I-beams as shown in cross section of boiler room. Provision is made to flood the pockets in case of the coal igniting and every precaution is taken to provide against such an occurrence, by thermometers placed in temperature pipes at different points of each pocket, from which a good idea of the actual temperature of the mass can be obtained. The coal is drawn from the pockets by gravity through cast-iron spouts and received into charging hoppers, which are arranged to travel on special tracks back and forth over the stoker grates in front of each boiler. These charging hoppers are arranged with Fairbanks scales for weighing the charge and hold approximately one ton each; they are operated by one man who charges them and also moves them from boiler to boiler. They are arranged to discharge directly into the stoker trough.

The stokers are of the Green "traveling grate" type, and are driven by individual shafting operated by 2-HP. vertical engines. The grates are 11 ft. wide and have about 110 sq. ft. of actual fire surface. Directly below and for the first 8 ft. back from the front of the grate is an opening in the floor through which all siftings from the grate fall into a sheet iron hopper from which the siftings are drawn off through cast-iron spouts and discharged, in the case of the upper floor boilers into the weighing hopper, and from these either to the lower floor stokers or possibly passed to the conveyor in the basement and by this taken back to the storage pockets to be mixed with the coal supply and burned over. The amount of these collection is some 10% of the coal passed into the stokers per day. The last 2 ft. of floor space under the grates is also open and through this the ashes drop to the ash hoppers, which are also of sheet iron, but are lined with fire brick.

FIG. 6. ERECTION OF ENGINE ROOM STEEL WORK, SHOWING USE OF 125-FT. GIN POLE.

The ashes fall by gravity through cast iron spouts discharging directly into the conveyor buckets and are conveyed by these into a large sheet iron ash bin in the conveyor tower at the east end of the station. This bin has a storage capacity of about three cars, and is built of sheet

iron, circular in shape, lined with hard brick. In loading, the ashes are discharged directly into cars at either track level.

All of the coal and ash handling machinery is driven by electric motors. The entire coal and ash handling plant, including the steel tower and storage tank, was furnished and erected by the John A. Mead Co. of New York.

In operating the coal supply plant, the cars on the upper (C. & A.) track are shoved in four at a time, and as each is unloaded it is crowded ahead by hand and a loaded car pushed into its place. The track has a grade of 1% to the coal tower. On the upper (K. C. S.) deck only one loaded car can be handled at a time, although there is a storage track capable of holding some eight or ten loaded cars extending along the south bluff parallel with the station. This siding is connected with the powerhouse switch by means of a Y, and the cars are handled by an electric motor supplied with power from an overhead trolley. This track has been connected with the street car line on Grand Ave., so that it is possible to take loaded ash cars to any part of the city, where the ashes may be required for grading or other purposes.

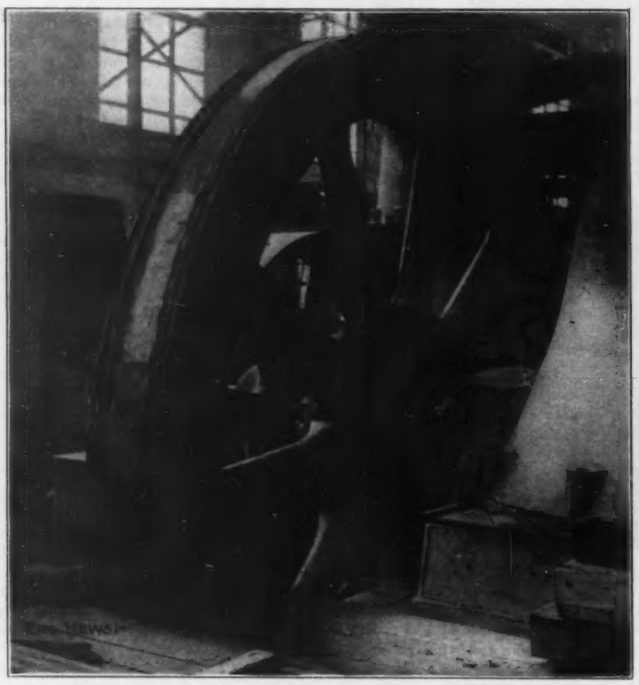


FIG. 7. ASSEMBLING ENGINE FLY-WHEEL.

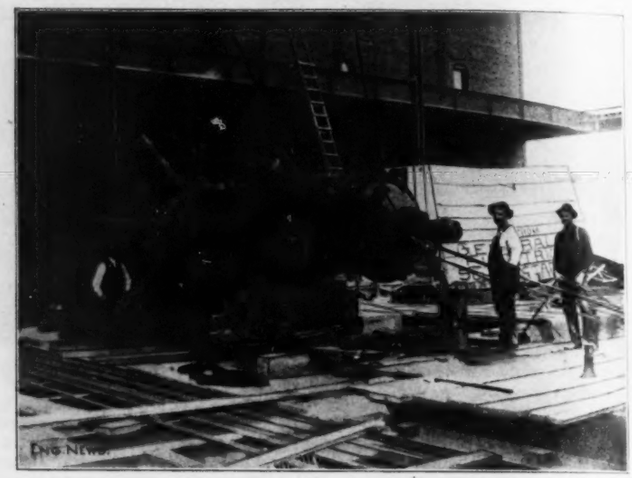


FIG. 8. FORCING POLE FIELD MAGNET SPIDER ON ENGINE SHAFT.

STACK.—A stack built by the Alphons Custodis Construction Co., of their hollow radial tile, furnishes the natural draft for the boilers. It is circular in section above the boiler room monitor or from a point 78 ft. above the base, is 16 ft. inside diameter and rises to a height of 265 ft. The base is octagonal in section and is built of hard burned brick to the height of the boiler room monitor. Smoke flues are of sheet steel covered with magnesia pipe covering. Automatic damper regulators control the draft and operate the 19-ft. damper in the stack itself.

MAIN ENGINES.—The engines, of which at present three are installed, are 4,600-HP. vertical cross-compound condensing engines, 46 and 94 ins. by 60 ins. stroke. Each is direct-connected to a 3,000-KW. electric railway generator, the armatures of the latter being keyed on the engine shaft. The engines are designed to run at 75 r. p. m., with 150 lbs. steam pressure.

Each cylinder is equipped with Reynolds-Corliss automatic valve gear, governed by an Allis-Chalmers special weighted governor that controls both high and low pressure valve gears. The governor is fitted with a safety stop to prevent running away when the governor-belt breaks. Steam and exhaust valves are driven by separate eccentrics.

The main journal is 34 ins. in diameter and 60 ins. long, while the journal frame is fitted with a bearing made in two parts, having one top and one bottom piece, and provided with adjustments for taking up wear. The bearings are lined with Babbitt metal, expanded in place, bored and scraped to fit the shaft, and provided with oil channels to effect an even distribution of oil over the entire surface of the journal. The lower shells are turned spherical in shape, and the receptacles for the shells in the bed plates themselves are turned to accurately fit these shells, providing perfect ball and socket journals. Arrangements are also made for circulating water through the lower half of the shells. The guides are also water-jacketed. The shaft is 37 ins. in diameter, of Bethlehem steel; the reduction from the center diameter to the diameter of the journals (34 ins.) is made with long fillets.

The balance wheel of the engine is 28 ft. in diameter and weighs 320,000 lbs. It was shipped in small sections and was assembled and dressed down on the work. The center or core consisting of ten cast iron segments was first placed in position and around this the wheel was built up of a series of 1-in. steel plates, which were cut to the radius of the wheel and assembled one at a time, 160 of these plates being used on each wheel. They were first assembled and held in place by bolts placed through holes in the cast iron segment of the wheel, and when the whole 160 plates had been fitted in position, the holes through plates and segment were reamed out to a diameter of 2¾ ins. and a rivet of this diameter was placed in the hole and upset cold by means of a hydraulic jack, exerting a pressure of 6,000 lbs. per sq. in. After the plates were securely riveted in place the entire wheel was turned down and trued up on the work. This was accomplished by means of a ratchet gear, bolted to the spokes of the wheel, and power was applied by connecting to a 50-HP. street car motor, a special lathe and cutting tools being furnished by the engine people for this purpose. Fig. 7 gives an idea of the character of this work. The crank and crosshead pins are 14 ins. in diameter and 14 ins. long. The approximate weight of the engine is 1,200,000 lbs. When running with 150 lbs. initial steam pressure, 75 r. p. m., and 26-in. vacuum, each engine will develop 4,600 I. HP. with a consumption of not to exceed 12 lbs. of dry steam per hour, per I. HP.

Steam supply is brought to the high pressure cylinder by two 10-in. Y branches from the main steam headers, which are united in a 12-in. starting valve; there is no separator or receiver at the high pressure cylinder, but there is a 6-in. by-pass from the starting valve to the intermediate receiver drum. The exhaust is through a 34-in. flanged pipe extending from the floor on the low pressure cylinder of engine to the condenser and to the exhaust-head on the roof. The section extending from the engine to condenser and relief valve is of cast iron flanged pipe and fittings. That leading from the relief valve to exhaust head is of mild steel riveted with cast iron flanges and nozzles. The main horizontal and vertical lines are of 48-in. riveted steel. The elbow at the foot of the vertical line rests upon a bed plate with roller bearings. On the 34-in. line from engine to condenser is placed a 48-in. Cochrane oil separator, with trap in each exhaust main between the atmospheric exhaust valve and the condenser; discharge from this trap is through a 4-in. line of washout pipe from the condenser. The atmospheric exhaust is through a 30-in. Blake flanged atmospheric valve fitted with hydraulic cylinders, 4-way valve and floor stand, with the necessary valves, pipes and fittings for water connection to the hydraulic cylinder. There is also a 36-in. vacuum line gate valve placed next to the oil separator connecting pipe. These 36-in. vacuum valves are arranged to operate by induction motors, and are the only motor operated valves in the plant.

In assembling the different parts of the engines a temporary track was laid into the east end of the building and the cars containing the engine parts run directly under the 60-ton traveling crane. The heaviest piece (single) was the hollow forged steel shaft of each engine, which was shipped naked except for fly wheel hubs, and weighed about 65 tons; this was blocked up on timbers and the generator "spider," or field hub, was pressed on and keyed, then the shaft and hubs was lifted by means of the crane and placed in position on the spherical bearings previously described for the journal seat. After the shaft was in its final position the crank disks were pressed on and the work of assembling the generator commenced. In placing the different pieces in position no special appliances were used and all of the work was carried on in the plant with the regular workmen. The most interesting operation was that of pressing on the generator spider. The bore of the spider hub was 0.004-in. smaller than the diameter of the shaft itself. Advantage was taken of the hollow shaft and a 7-in. bolt was passed through the 16-in. opening; by means of a nut and followers, or washers, together with a large wrench, which was worked by means of the electric crane, a pressure of over 300 tons was exerted on the spider, the nut on the end of the large bolt passing through the hollow shaft being gradually forced back and the spider crowded to place (Fig. 8.) The time required for the work of getting such a spider into position was about 48 hrs. of continuous labor. As soon as this was accomplished the shaft was lowered into position and the work of assembling "A" frames and cylinders proceeded, while at the same time

the cast iron segments of the flywheel were set up and the keys shrunk on. This latter proved an interesting work, as the links were heated red hot and driven to place with a battering ram weighing about 1,400 lbs., the links themselves weighing 1,200 lbs. Little difficulty was experienced and only one link had to be replaced for poor fitting. The work was carried on day and night, the erection of the plates proceeding as soon as the rim was in shape, each plate being numbered to correspond with a number of a certain segment of rim, and holes punched in plates to correspond to those turned through the segment, the last set of plates being provided with countersunk holes to receive the expanded rivet heads. After all the plates were in position the rivet holes were reamed out ¼-in. larger, through plate and segment, and 2¾-in. rivets upset hydraulically.

CONDENSERS.—These are Webster surface condensers of 5,000 HP. capacity, and are placed directly below the low pressure cylinder and at an elevation of about 3 ft. above the basement floor. The engines exhaust through a 48-in. Cochrane circular oil separator, a 34-in. to 48-in. increaser being placed in the 34-in. pipe line between the separator and the 34-in. valve which shuts off the condenser from the atmospheric exhaust line. The separators are equipped with Sorge drain traps and tanks, and have chronometer steam valves.

The condensing water enters at the bottom at one end through a 20-in. pipe, passes to the circulating tubes which are of copper, 1½ ins. in diameter, 1,680 in number, and out at the other end through a 20-in. pipe at the top of the condenser. This latter pipe drops, on leaving the condenser, to the basement floor and rises again at the discharge pipe, thereby forming a water seal which also acts as a siphon as soon as the circulating pumps are started, cutting down the head to be overcome in lifting the water to the condenser outlets. Valves are placed near the condensers on both the inlet and discharge pipes, and an air valve is placed in the outlet pipe for breaking the siphon vacuum. The air pumps are of the Blake vertical duplex beam type, 14 × 38 × 21 ins. The suction is placed several feet below the condenser outlet, while the overflow is several feet above the floor, thus giving a sufficient head to carry the condenser water back to the hot well in the boiler room basement by gravity. The circulating water for the condensers is supplied from a pump-house, located on the bank of the Missouri River, about 1,200 ft. from the station; it is furnished through a 48-in. cast iron bell and spigot pipe line, and the discharge is returned to the city sewer at a point near the southwest corner of the station, by a similar line.

PUMP HOUSE.—The pump house is one of the most modern electrical pumping plants ever installed. The building proper is rectangular in shape, 30 × 54 ft., and has an extreme height of 63 ft. from the bottom of the wells to the roof. The substructure is built entirely of concrete, on pile foundation. Considerable difficulty was experienced in sinking the caisson for this foundation, and in laying the bottom layer of concrete. At the time of the June flood of 1903 the caisson was about ready to be pumped out; after the flood receded it was found badly racked and full of river silt. When this latter had been removed the caisson was found in such a condition that it was not considered safe to pump it out and consequently the concrete had to be laid through about 20 ft. of river water. Although great pains was taken in depositing this concrete, and in clearing out the river silt, it was found at the expiration of three weeks to be of little value and, upon the water being lowered in the caisson gave way and allowed the river mud to pour into the latter; this delayed things materially and it was not until the early part of December, 1903, that the bottom was finally sealed, the caisson pumped out and the walls proper commenced. As finally constructed the bottom concrete is reinforced by old T rails laid about 18 ins. c. to c. and concreted into the main mass of the floor.

The substructure consists of a suction chamber and screen walls, and a pump chamber, this latter having the finished floor at Elev. — 1 ft., or 10 ft. above the floor of the suction chamber. The entire area of both suction and pump well is divided into compartments or cells, those of the suction chamber being about 10 × 11 ft., separated by 12-in. concrete walls, while the pump compartments are 11 × 15 ft. The bottom concrete is about 4 ft. thick while the outside walls are 3 ft. at the bottom reducing to 18 ins. at the top in three equal steps, finishing at elevation + 29 ft. to receive the brick superstructure. All the walls are of concrete reinforced with steel bars.

On the river side four 30-in. cast iron siphon pipes lead through the concrete wall to a point on the river bottom some 60 ft. beyond the building; at the end of the first 12-ft. length of pipe on each siphon, 45° elbows are used to deflect the horizontal pipe to the proper position on piles driven on the river bottom and to bring it to the depth required by the war department at the harbor line. The pipes are inclined down stream slightly, and no screens are used on the river ends, as the current, at this point quite rapid, has been found sufficient to keep the ends free from refuse. On the inside of the screen chamber the siphons drop directly to Elev. — 10 ft. or 1 ft. above the floor of the chamber. The 30-in. elbows are tapped for 2½-in. vacuum pump connections immediately inside the walls, and pipes lead to a 9 × 7-in. vertical duplex motor-driven Blake vacuum pump, located on the main floor of the pump-room; this pump is connected with all the siphons and pump suctions, each siphon having a gate valve placed on the vertical pipe, operating from a valve stand on the pump room floor. This is arranged with a set of bevel gears, enclosed in a special iron box and arranged for self oiling, as they will be under water most of the time. These gear chambers are filled each with 50 lbs. of No. 2 cup grease. Below the gates the siphon extends to a depth of 5 ft. below extreme low water; this is expected to leave under extreme conditions at least 2 ft. of water above the ends of the pipes for the pumps to draw on. Sluice gates are placed in the concrete walls of each siphon compartment on the river side of the screens, so that all can be thrown into one general chamber, or any particular well closed off for cleaning, etc. The screens divide the siphon chambers longitudinally into two compartments; on the river side are the siphons, and on the other are the pump suctions. These screens themselves are made of No. 6 galvanized wire 1-in. mesh set in angle-iron frames 4 × 6 ft. in size, are placed in pairs to form a double line, and are supported on a center post carrying a cast iron guide; each screen frame has a set of handles for raising and lowering it.

On the pump suctions are placed foot valves to prevent back flow, if pumps are stopped suddenly; each suction has gate valves and vacuum connections on the pump chamber side. The pumps are high lift centrifugals, made by the Morris Machine Co. of Baldwinsville, N. Y.; the equipment consists of three pumps each of 6,000 gallons per minute, and one pump of 3,000 gallons per minute capacity. The larger ones are arranged with 18-in. top suction pipes and 15-in. horizontal discharge pipes expanding to 18 ins. where they connect with the 48-in. cast-iron supply line, while the smaller pump is equipped with a 12-in. suction and 10-in. horizontal discharge expanding to 12 ins. at the main. The efficiency is 70% under a working head of 40 ft. The elevation of the pump wells is — 1.0 or 10 ft. above the bottom of the screen chambers. At times the river falls to — 6 ft., but for short periods only, and during the greater portion of the year the water will average as high as the pumps, while at times it will rise much higher, having, during the great flood of June 1, 1903, reached the height of the condenser outlets in the main power house. Gate valves are placed on all pump discharge pipes, so that any pump can be shut off from the main line at will, without interfering with the flow from any of the others. The pump chamber is waterproofed, so that access can be had to the pumps and bearings at any time, even when the river stands several feet above the pumps themselves. Sump wells are also provided and arranged to be connected with the pumps, so that all ordinary seepage can be taken care of.

The pumps are driven by induction motors, General Electric Co. Type "K," three-phase, 25-cycle, 440 volts, running 375 r. p. m. The larger pumps are connected to 125-KW. motors and the smaller to a 75-KW. motor, by means of flexible couplings joining the vertical shafts directly below the pump room floor; these couplings are supported by bearings on the motor and by a special clamp to the steel floor beams. The motor settings are provided with set screws so that the motor feet can be perfectly aligned with pump shaft, both vertically and horizontally, in the motor shoes.

The starting compensators and switches are located in the west end of the building, the wires being brought into a special wire chamber under the pump-room floor, and from this are extended to compensators and motors, through iron conduits. The lighting circuits are carried along the walls, the switch panel being placed on the wall at the southwest corner of the station. All current is taken from the 440-volt circuit, and is supplied from the main powerhouse transformers, located on the main engine room floor, which are of the General Electric oil-cooled type, arranged in delta; with the exception of the current required to operate the switchboard devices and the oil switch motors, this is the only current transformed at the plant.

The entrance to the pumphouse is at the east end, and the entire floor is covered by a 5-ton crane, arranged for hand operation, with the exception of hoisting the load. For this operation the trolley is equipped with a General Electric Co., Type "M," induction motor, 440-volt, the controller and resistances being mounted on the trolley. The interior of the station consists of a main pump-room 30 × 54 ft., with a projection on the south side 13 × 25 ft., which is arranged as an entrance ventibule in the center with rooms opening to the right and left, used respectively as an operators record room and office and as a lavatory and store room. The superstructure is of brick, with steel floor and roof beams, both floor and roof being reinforced concrete.

ELECTRIC EQUIPMENT.—General Electric apparatus is used throughout the entire equipment. At present three 3,000-KW. 40-pole, 6,600-volt, 25-cycle, three-phase generators operating at 75 r. p. m., are installed. Future extensions of the plant contemplate the installation of six 5,000-KW. Curtis steam turbines, and arrangements are rapidly being completed for placing two of these during the present summer. Two exciter sets consisting of one motor-driven 6-pole 150-KW. 500 r. p. m. 125-volt shunt wound direct current generator, mounted on a common base with a 6-pole, 200-HP. 500 r. p. m., 350-volt three-phase induction motor are provided. These, with the necessary rheostats, starting resistances and six 25-cycle 60-KW., 6,600 to 370 volt transformers (oil cooled), furnish the equipment for field excitation of main unit and for operation of switches, etc. All station wiring is run in iron pipe conduits placed in the concrete floors and galleries, which lead to the current and potential transformers, rheostats, switch motors, engine signal and control motors, exciter switchboard, etc. The main switchboard is of black enamel slate, and is a combination operating bench and panel; the panel portion supports the usual current measuring and recording instruments to be found on an alternating current board and is fully equipped for station operation and record.

The oil switches are located on the main engine room floor, directly to the north of the engines, and under the switchboard or steam-pipe gallery. These are of Type "H" and are of 300, 350 and 1,200 amperes capacity, and are set on slate slabs which in turn are supported by concrete cells; these cells are in groups corresponding to each generator unit as follows: One generator switch, five feeder switches, one exciter switch, and one group switch. The bus-bars are located directly below the oil switches on the gallery, at Elev. + 29. These compartments (3) as well as the vertical barriers, are made of one continuous slab of concrete; this is one of the first attempts at building a continuous concrete bus-bar and barrier compartment with oil switch cells of concrete, in the country.

Great care was taken with this work, and while the compartments were of very small size (14 × 14 ins. inside measurement) and in three tiers, with barriers connected at the back, the work was carried out successfully, and by the means of light collapsible forms the 2-in. and 3-in. con-

crete walls were carried up as one piece; for reinforcement barbed wire was used, spaced about 18-ins. apart in both side slabs and in the barriers. Where the work had to be allowed to stand it was doweled together by setting ten-penny nails in the soft concrete slab where the edge of the next wall would rest, and when the work was commenced again these were concreted in and formed a series of dowel pins, as it were, making a tight and satisfactory joint. These compartments were erected faster and cheaper than similar ones of brick.

COST.—The cost of the plant, including equipment, was approximately $2,000,000. No pains were spared to make it as complete in every respect as modern engineering skill could devise, and its present low cost of electrical output has justified the expenditure. Power is now being generated at a cost of less than $0.004 per kilowatt-hour at the station busses.

The engineering features were designed and carried out in the Kansas City office of Ford, Bacon & Davis, consulting engineers for the road, their office being in charge of Mr. Charles N. Black, the present general manager of the system. The powerhouse construction and equipment were under the personal supervision of the writer, F. G. Cudworth, Assoc. M. Am. Soc. C. E., now of the firm of Cudworth, Axtell & Co., engineers, Kansas City, Mo., at that time assistant engineer on the staff of Ford, Bacon & Davis.

THE NEW PHILADELPHIA BUILDING REGULATIONS FOR CONCRETE BLOCKS.

Specific rules governing the manufacture, testing and use of concrete blocks for building construction have been adopted by the Bureau of Building Inspection of Philadelphia, Pa. So far as we know these are the first official rules established by any municipality in this country upon the basis of actual tests of hollow concrete blocks and relating specifically to such forms of blocks. Late in 1904 and early in 1905 a series of tests were made at Columbia University, New York City, on common building brick for the purpose of determining a standard of strength to which such newer materials as lime-sand bricks and concrete blocks should conform when offered for building construction in New York City. Based on the results of these tests a set of regulations was drawn up and adopted by the Department of Buildings. These regulations and a full account of the tests on which they were based were published in Engineering News of April 13, 1905.

Without further investigation the Philadelphia Bureau of Building Inspection adopted the New York code and began its enforcement. When, however, the concrete block manufacturers began to offer their material for testing, it was discovered that while the requirements and methods of tests prescribed applied well enough to concrete in solid blocks of brick size they were wholly inapplicable to hollow concrete blocks. It was therefore decided to make independent tests. These tests were made in the laboratory of the Henry S. Spackman Engineering Co., of Philadelphia, Pa. Hollow concrete blocks selected at random from the yards of local manufacturers were tested in comparison with solid concrete blocks, and with building brick built into blocks or piers of the same size as the hollow concrete blocks. Based on the results of these tests a new code of rules was adopted by the Bureau. These rules are printed herewith.

RULES AND REGULATIONS COVERING THE MANUFACTURE AND USE OF HOLLOW CONCRETE BUILDING BLOCKS IN THE CITY OF PHILADELPHIA.

1. Hollow concrete building blocks may be used for building six stories or less in height, where said use is approved by the Bureau of Building Inspection, provided, however, that such blocks shall be composed of at least one (1) part of standard Portland cement, and not to exceed five (5) parts of clean, coarse, sharp sand or gravel, or a mixture of at least one part of Portland cement to five (5) parts of crushed rock or other suitable aggregate. Provided further, that this section shall not permit the use of hollow blocks in party walls; said party walls must be built solid.

2. All material to be of such fineness as to pass a ½-in. ring and be free from dirt or foreign matter. The material composing such blocks shall be properly mixed and manipulated, and the hollow space in said blocks shall not exceed the percentage given in the following table for different height walls, and in no case shall the walls or webs of the block be less in thickness than one-fourth of the height. The figures given in the table represent the percentage of such hollow space for different height walls.

Stories.	1st.	2d.	3d.	4th.	5th.	6th.
1 and 2	33	33				
3 and 4	25	33	33	33		
5 and 6	20	25	25	33	33	33

3. The thickness for walls for any building where hollow concrete blocks are used shall not be less than is required by law for brick walls.

4. Where the face only is of hollow concrete building block and the backing is of brick, the facing of hollow concrete blocks must be strongly bonded to the brick either with headers projecting 4 ins. into the brick work, every fourth course being a heading course, or with approved ties, no brick backing to be less than 8 ins. Where the walls are made entirely of hollow concrete blocks, but where said blocks have not the same width as the wall, every fifth course shall extend through the wall, forming a secure bond. All nails where blocks are used shall be laid up in Portland cement mortar.

5. All hollow concrete building blocks before being used in the construction of any buildings in the City of Philadelphia shall have attained the age of at least three (3) weeks.

6. Wherever girders or joists rest upon walls so that there is a concentrated load on the block of over two (2) tons, the blocks supporting the girder or joists must be made solid. Where such concentrated load shall exceed five (5) tons, the blocks for two (2) courses below, and for a distance extending at least 18 ins. each side of said girder shall be made solid. Where the load on the wall from the girder exceeds five (5) tons, the blocks for three (3) courses underneath it shall be made solid with similar material as in the blocks. Wherever walls are decreased in thickness the top course of the thicker wall to be made solid.

7. Provided always that no wall or any part thereof composed of hollow concrete blocks shall be loaded to an excess of eight (8) tons per superficial foot of the area of such blocks, including the weight of the wall and no blocks shall be used that have an average crushing at less than 1,000 lbs. per sq. in. of area at the age of 28 days, no deduction to be made in figuring the area for the hollow spaces.

8. All piers and buttresses that support loads in excess of five (5) tons, shall be built of solid concrete blocks for such distance below as may be required by the Bureau of Building Inspection. Concrete lintels and sills shall be reinforced by iron or steel rods in a manner satisfactory to the Bureau of Building Inspection, and any lintels spanning over 4 ft. 6 ins. in the clear shall rest on solid concrete blocks.

9. Provided, that no hollow concrete building blocks shall be used in the construction of any building in the City of Philadelphia, unless the maker of said blocks has submitted his product to the full test required by the Bureau of Building Inspection, and placed on file with said Bureau of Building Inspection, a certificate from a reliable testing laboratory showing that samples from the lot of blocks to be used have successfully passed the requirements of the Bureau of Building Inspection, and filing a full copy of the test with the Bureau.

10. A brand or mark of identification must be impressed in or otherwise permanently attached to each block for purpose of identification.

11. No certificate of approval shall be considered in force for more than four months unless there be filed with the Bureau of Building Inspection, in the City of Philadelphia, at least once every four months following, a certificate from some reliable physical testing laboratory showing that the average of three (3) specimens tested for compression, and three (3) specimens tested for transverse strength comply with the requirements of the Bureau of Building Inspection of the City of Philadelphia, samples said to be selected either by a building inspector or by the laboratory, from blocks actually going into construction work, samples must not be furnished by the contractors or builders.

12. The manufacturer and user of any such hollow concrete blocks as are mentioned in this regulation, or either of them, shall at any and all times have made such tests of the cements used in making such blocks or such further tests of the completed blocks, or of each of these, at their own expense, and under the supervision of the Bureau of Building Inspection, as the Chief of said Bureau shall require.

13. The cement used in making said blocks shall be Portland cement, and must be capable of passing the minimum requirements as set forth in the "Standard Specifications for Cement" by the American Society for Testing Materials.

14. Any and all blocks, samples of which on being tested under the direction of the Bureau of Building Inspection, fail to stand at 28 days, the tests required by this regulation, shall be marked condemned by the manufacturer or user and shall be destroyed.

15. No concrete blocks shall be used in the construction of any building within the City of Philadelphia until they shall have been inspected, and average samples of the lot tested, approved and accepted by the Chief of the Bureau of Building Inspection.

SPECIFICATIONS GOVERNING METHOD OF TESTING HOLLOW BLOCK.

1. These regulations shall apply to all new materials such as are used in building construction, in the same manner and for the same purposes, as stones, brick, concrete, are now authorized by the building laws, where said new material to be substituted departs from the general shape and dimensions of ordinary building brick and more particularly to that form of building material known as hollow concrete block manufactured from cement and a certain addition of sand, crushed stone or similar material.

2. Before any such material is used in building an application for its use and for a test of the same must be filed with the Chief of the Bureau of Building Inspection. A description of the material and a brief outline of its manufacture and proportions of the material used must be embodied in the application.

3. The material must be subjected to the following tests: Transverse, compression, absorption, freezing and fire. Additional tests may be called for when, in the judgment of the Chief of the Bureau of Building Inspection, the same may be necessary. All such tests must be made in some laboratory of recognized standing, under the supervision of the engineer of the Bureau of Building Inspection. The tests will be made at the expense of the applicant.

4. The results of the tests, whether satisfactory or not, must be placed on file in the Bureau of Building Inspection. They shall be open to inspection upon application to the Chief of the Bureau, but need not necessarily be published.

5. For the purposes of the tests, at least twenty (20) samples or test pieces must be provided. Such samples must represent the ordinary commercial product. They may be selected from stock by the Chief of the Bureau of Building Inspection, or his representative, or may be made in his presence, at his discretion. The samples must be of the regular size and shape used in construction. In cases where the material is made and used in special shapes and forms too large for testing in the ordinary machines, smaller sized specimens shall be used as may be directed by the Chief of Bureau of Building Inspection, to determine the physical characteristic specified in Section 3.

6. The samples may be tested as soon as desired by the applicant, but in no case later than 60 days after manufacture.

7. The weight per cubic foot of the material must be determined.

8. Tests shall be made in series of at least five, except that in the fire tests a series of two (four samples) are sufficient. Transverse tests shall be made on full sized samples. Half samples may be used for the crushing, freezing and fire tests. The remaining samples are kept in reserve, in case unusual flaws, or exceptional or abnormal conditions make it necessary to discard certain of the tests. All samples must be marked for identification and comparison.

9. The transverse tests shall be made as follows: The samples shall be placed flatwise on two rounded knife edge bearings set parallel, 7 ins. apart. A load is then applied on top, midway between the supports, and transmitted through a similar rounded knife edge, until the sample is ruptured. The modulus of rupture shall then be determined by multiplying the total breaking load in pounds by 21 (three times the distance between supports in inches) and then dividing the result thus obtained by twice the product of the width in inches by the square of the depth in inches. $R = \frac{3\,W\,l}{2bd^2}$. No allowance should be made in figuring the modulus of rupture for the hollow spaces.

10. The compression test shall be made as follows: Samples must be cut from blocks so as to contain a full web section; samples must be carefully measured, then bedded flatwise in plaster of paris to secure a uniform bearing in the testing machine and crushed. The total breaking load is then divided by the area in compression in square inches. No deduction to be made for hollow spaces; the area will be considered as the product of the width by the length.

11. The absorption tests must be made as follows: The sample is first thoroughly dried to a constant weight. The weight must be carefully recorded. It is then placed in a pan or a tray of water, face downward, immersing it to a depth of not more than ½ in. It is again carefully weighed at the following periods: 30 minutes, four hours, and 48 hours, respectively, from the time of immersion, being replaced in the water in each case as soon as the weight is taken. Its compressive strength, while still wet, is then determined at the end of the 48-hour period in the manner specified in Section 10.

12. The freezing tests are made as follows: The sample is immersed, as described in Section 11, for at least four hours and then weighed. It is then placed in a freezing mixture or a refrigerator, or otherwise subjected to a temperature of less than 15° F. for at least 12 hours. It is then removed and placed in water, where it must remain for at least one hour, the temperature of which is at least 150° F. This operation is repeated ten times,

after which the sample is again weighed while still wet from the last thawing. Its crushing strength should then be determined as called for in Section 10.

12. The fire test must be made as follows: Two samples are placed in a cold furnace in which the temperature is gradually raised to 1,700° F.; the test piece must be subjected to this temperature for at least 30 minutes. One of the samples is then plunged in cold water (about 50° F. to 60° F.) and the results noted. The second sample is permitted to cool gradually in air, and the results noted.

14. The following requirements must be met to secure an acceptance of the materials: The modulus of rupture for concrete blocks at 28 days old must average 150 and must not fall below 100 in any case. The ultimate compressive strength at 28 days must average 1,000 lbs. per sq. in., and must not fall below 700 lbs. in any case. The percentage of absorption (being the weight of water absorbed divided by the weight of the dry sample) must not average higher than 15% and must not exceed 20% in any case. The reduction of compressive strength must not be more than 33⅓%, except that when the lower figure is still above 1,000 lbs. per sq. in., the loss in strength may be neglected. The freezing and thawing process must not cause a loss in weight greater than 10% nor a loss in strength of more than 33⅓%, except that when the lower figure is still above 1,000 lbs. per sq. in., the loss in strength may be neglected. The fire test must not cause the material to disintegrate.

15. The approval of any material is given only under the following conditions:

(a) A brand mark for identification must be impressed on or otherwise attached to the material.

(b) A plant for the production of the material must be in full operation when the official tests are made.

(c) The name of the firm or corporation and the responsible officers must be placed on file with the Chief of the Bureau of Building Inspection, and changes in the same promptly reported.

(d) The Chief of the Bureau of Building Inspection may require full tests to be repeated on samples selected from the open market, when, in his opinion, there is any doubt as to whether the product is up to the standard of these regulations and the manufacturer must submit to the Bureau of Building Inspection once in at least every four months a certificate of tests showing that the average resistance of three specimens to cross breaking and crushing are not below the requirements of these regulations. Such tests must be made by some laboratory of recognized standing on samples selected by a building inspector or the laboratory, from material actually going into construction, and not on ones furnished by the manufacturer.

(e) In case the results of tests made under these conditions should show that the sandard of these regulations is not maintained, the approval of this bureau to the manufacturer of said blocks will at once be suspended or revoked.

Tests made under the specifications of the City of Philadelphia on concrete blocks in the market here have developed about the following results: Modulus of rupture, 150 to 175 lbs.; compressive strength, 1,200 to 1,600 lbs. per sq. in.; absorption, 5%.

The compressive strength is reduced little, if any, by the water absorbed. Freezing tests show little loss. The average compressive strength after freezing is in the vicinity of 1,000 lbs. per sq. in. The blocks passed the fire tests well.

THE KEY WEST EXTENSION OF THE FLORIDA EAST COAST RAILWAY.

One of the most interesting pieces of railway construction now under way in the South is the Key West Extension of the Florida East Coast Ry. This new line will follow the outlying Florida Keys for nearly their whole length, and about 30 miles of it will be over what is now open water. Two types of construction are required; one is embankment construction on land and in shallow water and the other is reinforced concrete arch viaduct construction over deeper water. Altogether there will be over six miles of the viaduct work in four stretches varying from one mile to two miles in length. The engineer of this work is Mr. J. C. Meridith, Constructing Engineer, Miami, Fla., with Mr. R. W. Carter as Bridge Engineer. We are indebted to Mr. Carter for the information from which this account of the work was prepared.

A map of the proposed extension is given by Fig. 1. The new line starts from the old road at Homestead Station 28 miles south of Miami, and for 21 miles further continues on the main land. It then crosses to Key Largo, which is the largest of the Florida Keys, where it turns sharply and follows the line of outlying Keys southwesterly to Key West. The Florida Keys, as is shown by the map, are separated by openings or channels varying in width from a few rods to several miles, and in depth of water from a bare wash to a score or more feet. It is the extent of these water crossings, some 30 miles, that is the distinctive feature of the construction work.

EMBANKMENT CONSTRUCTION.—Of the 128 miles of new line, something like 98 miles are solid fill embankment or through cut. This work comprises all the line on land and some four-fifths of the line over water. The fill-in water will in some cases be of rock, but more usually this will be of marl or sand dredged from the bottom near the right of way. It is planned to place most of this filling with vacuum dredges, as by this process the dredge discharge has a much greater percentage of solids than does usually the discharge of hydraulic dredges, which will also be tried. Orange peel and clam shell dredges will likewise be used; nearly all of the roadbed on the mainland will be placed by such dredges working on both sides of the fill and digging their own channels as they progress. This mainland portion of the line lies through low lands subject to frequent overflow. On the Keys themselves the work will be very light and nearly all embankment. Such cuts as these are are through rock too soft for ballast or for concrete.

VIADUCT CONSTRUCTION. The deep water crossings requiring viaducts are four in number, and the viaduct structures will be, respectively, 10,500 ft., 5,200 ft., 7,300 ft. and 7,800 ft. long. A standard arch construction in reinforced concrete will be employed. This construction is shown in Figs. 2, 3 and 4; it consists of full centered concrete arches of 50 ft. span carried on concrete piers founded on solid rock or on piles, according to the character of the bottom. Every fifth pier is 12 ft. thick at the springing line of the arches, and the intermediate piers are 9 ft. thick at the corresponding level. The piers will all be founded on soft coral rock, which in some cases will admit of driving piles and in other cases will not. Where piles can be driven they will be used for anchorage, as shown by the drawings. It is planned to use 28 piles under the large piers and 21 under the smaller piers. Where the rock will not admit of driving piles a pit 2 ft. deep will be excavated and the pier founded therein. The maximum depth of water at the various crossings varies from 13 ft. to 25 ft. In water over 13 ft. deep the piers are stepped out as shown by the drawings. The top of the step is 12 ft. below the springing line and the ratio of the steps is to be for the 9-ft. piers one horizontal to four vertical, and for the 12-ft. piers one horizontal to three vertical. Mean low water level is about springing line level.

Details of both forms of piers and the general arrangement of the arch ring and spandrel wall reinforcement are shown by the drawings of Fig. 3. These drawings require no explanation except in respect to one or two details shown in larger scale by Fig. 4. Referring to the soffit reinforcement of the arch ring notice should be taken of the manner of connecting successive lengths of the circumferential bars by welded links and wedges. Mention may also be made of the spacing bar employed to connect the intradosal and extradosal reinforcing network and of the bonding of the spandrel wall reinforcement into the arch ring. Corrugated bars are planned for reinforcement throughout. As the rock along the route is nowhere hard enough for ballast or for concrete all stone for these purposes will have to be brought from a distance. The same thing is true of sand, the nearest point of supply of which is Miami. The engineers state that fresh water only will be used for concrete as tests made by the railway company indicate that steel rusts rapidly in concrete which has been mixed with salt water.

The adoption of reinforced concrete arches for the viaduct work of the line was based partly upon the increased durability of this form of construction over steel spans but more upon their greater weight, which is of decided benefit in resisting the overturning action of the waves. The deep water openings where the viaducts are built are of course the points most exposed to wave action, and all the viaducts were especially designed to withstand these forces. In order to discover as nearly as possible what height of waves and what pressures the several structures would have to resist, contour maps extending beyond all outlying reefs were prepared for each opening, and the corresponding structure was designed to withstand the highest wave that could cross these reefs unbroken.

In conclusion, it may be mentioned that all of the construction work will be done by the railway company itself without the aid of constructors. The many risks incidental to the work exposed to the sea; the unknown factors involved in placing the long fills in water; the distance from a base of supplies and the large equipment

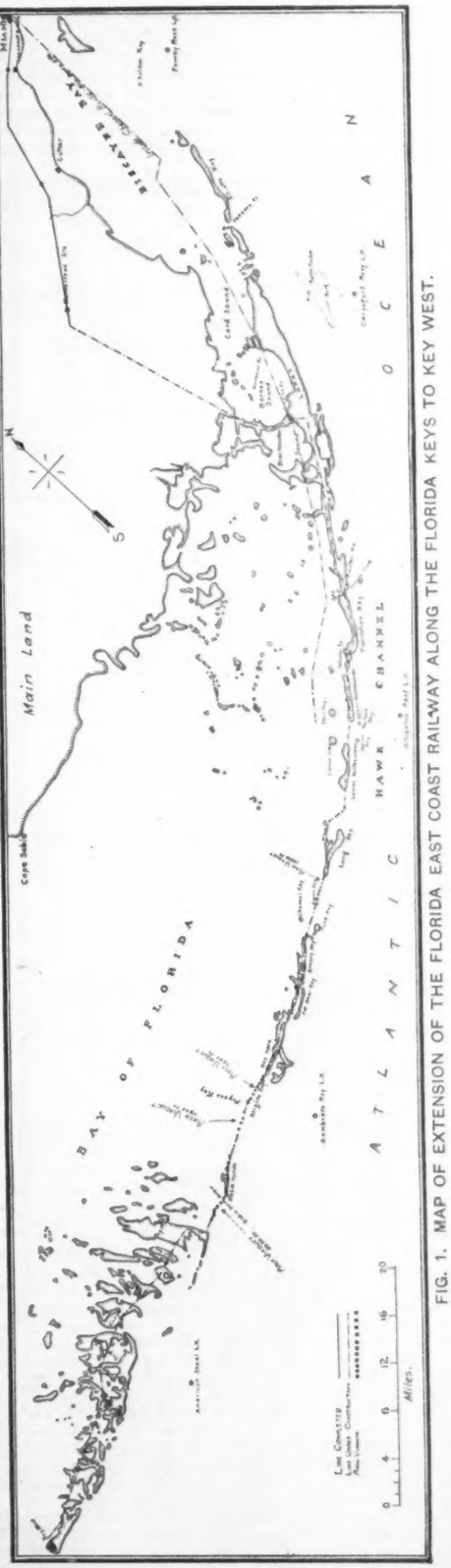


FIG. 1. MAP OF EXTENSION OF THE FLORIDA EAST COAST RAILWAY ALONG THE FLORIDA KEYS TO KEY WEST.

required, in connection with the supposed unhealthfulness of the climate, combined to render the work unattractive to contractors except at a price so high that the railway company considered it best to take all of the risks and handle all the work itself. The company is now buying equipment and getting an organization into shape for handling the various classes of work. The time assigned for the completion of the extension to Key West, where extensive docks and terminal facilities will be built, is three years. The total length of the extension from Homestead to Key West is 128 miles.

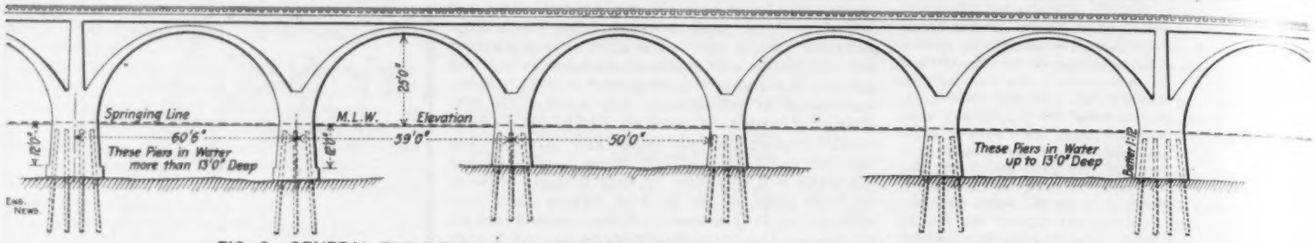


FIG. 2. GENERAL ELEVATION OF REINFORCED CONCRETE VIADUCT, FLORIDA EAST COAST RY.

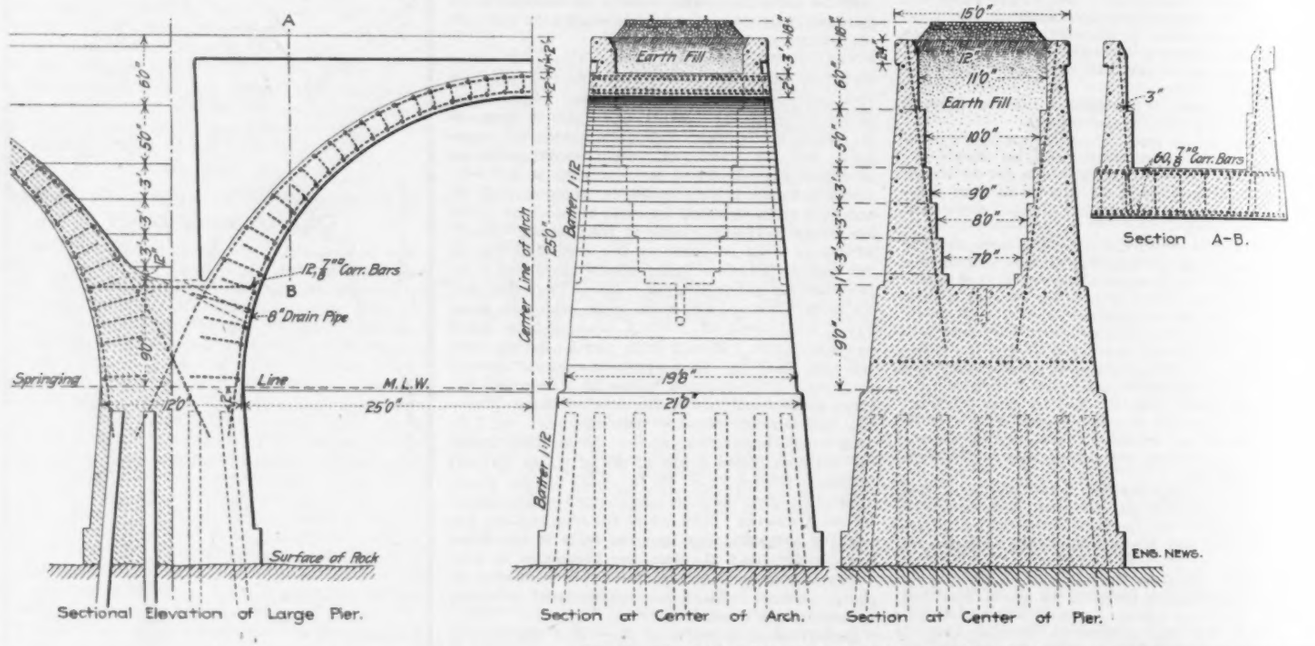
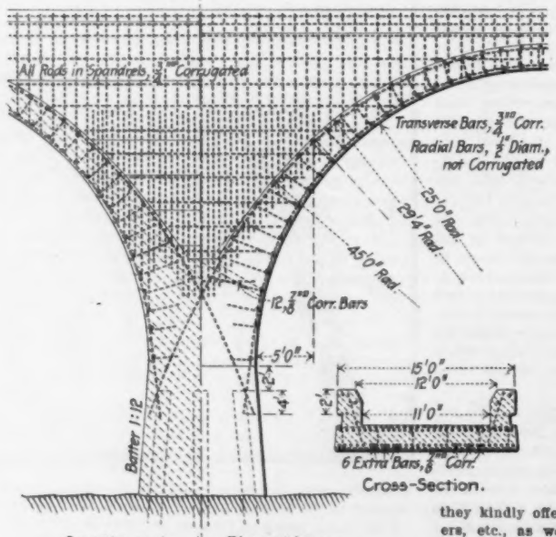


FIG. 3. DETAILS OF PIER AND ARCH CONSTRUCTION FOR REINFORCED CONCRETE VIADUCTS.



THE DESIGN, CONSTRUCTION, EFFICIENCY AND MAINTENANCE OF SIGNAL LAMPS.*

The question of securing the most satisfactory and at the same time the most economical night indication for signals is commanding the attention of the railroad world. In order that this might be brought before the association, a resolution was passed at the annual meeting held in St. Louis, October, 1904, creating the committee for the purpose of collecting such data as would enable them to present a full and comprehensive report at this meeting, particularly as to the efficiency of the long-time burner.

In presenting this report, it is the intention to confine it to a description of various tests made, results obtained and data collected during the last ten months, subdividing same as follows: (1) Design and construction of lamp; (2) Comparative value in efficiency and candle power between the one-day and long-time burner, including tabulated results from range and photometric tests; (3) Illuminating oil; brand best adapted for long-time burners; also a comparison of the quantity consumed by the one-day and long-time burner; (4) Maintenance of lamps; (5) Conclusions.

That the best possible results might be obtained, three well known lamp manufacturers, namely: Adams & Westlake, Dressel & Armspear, were invited to cooperate in making the tests. Having accepted the invitation, they kindly offered to furnish all necessary lamps, burners, etc., as well as send representatives to assist in every way possible in making them a success.

DESIGN AND CONSTRUCTION OF LAMP.

There is no doubt but that within the last decade, more attention has been given to the construction of signal and switch lamps than at any time previous; while it is true that manufacturers have at all times endeavored to place on the market that which would meet the requirements, they did not have the same cooperation of the consumer, as to what would give best results as has been the case in the last few years.

The point now is not to use the cheapest, but the most durable, as well as the lamp that will give the most efficient light with the least possible accumulation of moisture, at the same time, so designed as to give proper ventilation without the possibility of the flame being blown out by high winds or smothered by heavy weather. The old tin lamps (of which there are still a large number in use) have given considerable trouble. After a few years service, they become practically worthless; the solder becoming loose, corrosion sets in, due to action of the elements causing the flame to be extinguished by any ordinary windstorm. The latest design of lamp provides for steel construction, all parts being riveted, thereby eliminating the use of solder; consequently, there is no possibility of damage to the lamp should it become overheated. This construction also prevents the lamp from being battered by falling from a pole or by rough usage.

The question of ventilation has also been given careful consideration. Some claim that a lamp should be designed with a bottom draft, so that the air would have a direct path, and at the same time overcome the danger of overheating the oil pot. In one design of bottom draft, a perforated plate is used, placed above the openings to prevent the air from coming in direct contact with the flame. This design has also been modified to include the top draft feature which is obtained by having a series of small openings in the upper portion of the lamp body which can be closed if not required, the object of this being that it may be desirable to use either according to climatic conditions.

Another system of ventilation is in use known as the top draft; it is accomplished in the following manner: Top of lamp has a series of holes for intake of air, a perforated cylinder fastened to the top and a cone placed on the inside of same. The claim made is that the air entering lamps, follows the outer surface of cone, passes through perforations and strikes the body of the lamp and lenses on its downward path (thereby preventing the collection of moisture) thence to the oil pot, feeds the flame and passes out through ventilator.

*Report of Committee of Railway Signal Association Annual Meeting, Niagara Falls, N. Y., Oct. 10, 11, and 12, 1905, Chairman of Committee; C. C. Rosenberg, Signal Engineer, Lehigh Valley R. R., South Bethlehem,

The lamps as described above were designed for a one-day burner. It has been a question with some whether the long-time burner could be successfully used in these, owing to the difference in size of flame. Actual service has proven that the best of results can be obtained.

WIND PRESSURE TESTS.—In order to conceive some idea of the amount of wind pressure necessary to extinguish the flame in lamps equipped with long-time burners, a test was made by placing a number of lamps against a partition and applying an air pressure, varying from 30 to 80 lbs. (using a 1-in. hose), air being

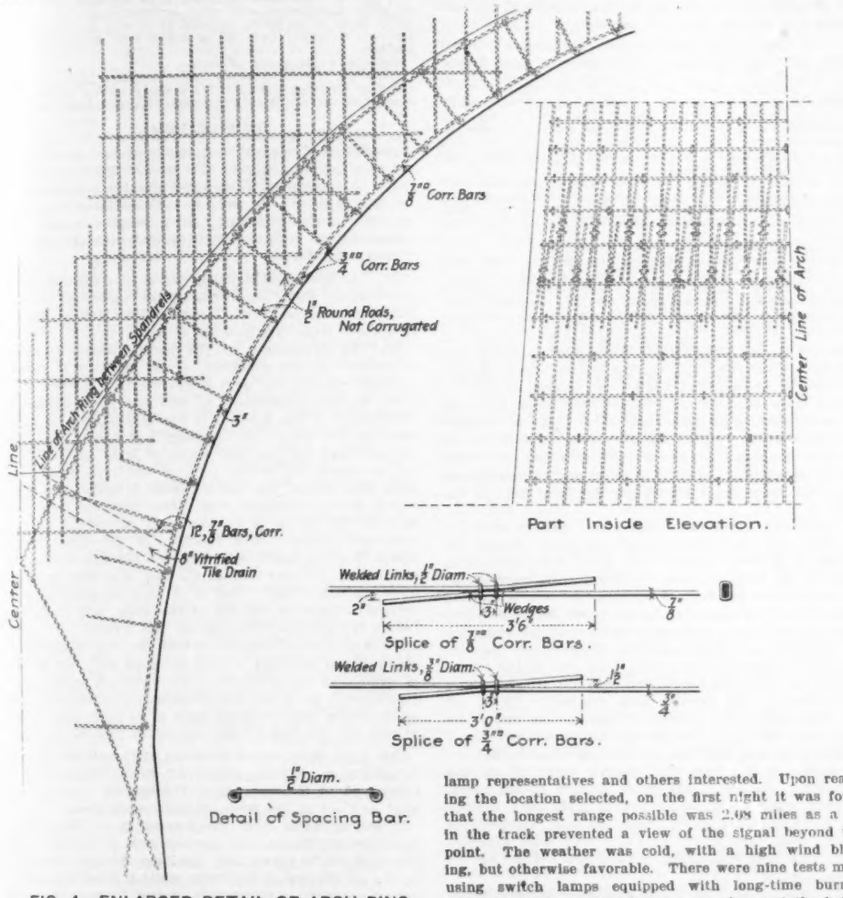


FIG. 4. ENLARGED DETAIL OF ARCH RING REINFORCEMENT.

turned on lamps at a distance of 8 ft. and gradually approached, noting point at which the light was extinguished.

Two lamps furnished by each of the manufacturers heretofore mentioned were used and are designated as follows: Nos. 1, 2, 3, 4 top draft; No. 5 combination top and bottom draft—top draft used; No. 6 bottom draft. They were tested after burning 24 hours and every 24 hours thereafter for a period of four days. The tests were as follows:

1st test—80 lbs. pressure.
Lamp 5 extinguished at 4 ft.
Lamps 1 and 4 extinguished by forcing air in at top.
Lamp 6 extinguished at 1 ft.
Lamps 2 and 3 unable to extinguish.

2d test—50 lbs. pressure.
Lamp 5 extinguished at 6 ft.
Lamps 1 and 4 extinguished by forcing air in at top.
Lamp 5 extinguished by forcing air in at bottom.
Lamps 2 and 3 unable to extinguish.

3d test.
Lamp 5 extinguished at 2 ft.—40 lbs. pressure.
Lamps 1 and 4 extinguished by forcing air in at top —60 lbs. pressure.
Lamp 6 withdrawn.
Lamps 2 and 3 unable to extinguish.

4th test.
Lamp 5 extinguished at 1½ ft.—30 lbs. pressure.
Lamps 1, 2 and 4 extinguished by forcing air in at top.—65 lbs. pressure.
Lamp 3 unable to extinguish.

Tests made after lamps were in actual service 4 days on switches and signal poles:

Lamp 5 extinguished at 1 ft.—30 lbs. pressure.
Lamp 6 extinguished with nozzle of hose against bottom of lamp.—40 lbs. pressure.
Lamps 1 and 4 extinguished with nozzle of hose against top of lamp.—50 lbs. pressure.
Lamp 3 extinguished with nozzle of hose against top of lamp.—70 lbs. pressure.
Unable to extinguish lamp 2.—70 lbs. pressure, which was all that could be obtained at that time.

COMPARATIVE VALUE IN EFFICIENCY AND CANDLE POWER BETWEEN ONE-DAY AND LONG-TIME BURNER.

SIGHT TESTS.—The first point determined was the distance at which a lamp equipped with a long-time burner would be considered an efficient signal, or in other words, the maximum distance at which an engineman would be able to pick up a signal so equipped and distinguish its color. To arrive at this, a series of tests were made, using an observation engine, on the Lehigh Valley R. R. about 20 miles east of Buffalo, on Nov. 29 and 30, 1904, the party consisting of railroad officials, lamp representatives and others interested. Upon reaching the location selected, on the first night it was found that the longest range possible was 2.08 miles as a dip in the track prevented a view of the signal beyond this point. The weather was cold, with a high wind blowing, but otherwise favorable. There were nine tests made using switch lamps equipped with long-time burners without reflectors. The flames were placed at the height of ⅞-in., which was agreed upon by all present. The results will be found in the following tabulated statement, attention being called to the difference in range at which these were obtained.

Test. No.	Lens—Size, ins.	Color.	Range, miles.	Results.
1	5⅜	Ruby	2.08	Very good signal.
2	5⅜	Green	2.08	Good signal.
3	5⅜	Yellow	1.05	Good signal.
4	4½	Yellow	1.05	Good signal.
5	4	Green	1.0	Fair signal—color dense
6	4½	Ruby	2.08	Very good signal.
7	4½	Yellow	1.1	Good signal.
8	4	Green	1.85	Good signal.
9	4½	Ruby	2.08	Very good signal.

As a longer range was desired for the ruby, it was decided to discontinue tests until the following night and an effort be made to extend same. The weather on the second night was stormy, snowing very hard when the first test was made which was with a switch lamp equipped with 5⅜-in. ruby lens, long-time burner without reflector. This displayed a distinct signal for a distance of 0.8 miles, notwithstanding the fact that the hood or collar around the lens was completely filled with snow.

A short time after this test had been made, the weather cleared and tests Nos. 1 and 6 of the previous night were repeated at a distance of 3.31 miles at which point they still displayed a very clearly defined signal. This being the limit of range, the opinion of all present was that under no conditions would it be necessary to display a signal for so great a distance and the result was, therefore, considered satisfactory even for heavy weather. As the limit of the green and yellow had been reached the night previous, no further tests were made with these colors.

Tests on roundels were then taken up, the following scheme being used: A car was fitted up for the purpose of placing the roundels and lamps in the same relative position as on the signal pole. The lamps used were standard semaphore type equipped with white lens, long-time burner and one-way reflector. The roundels used were solid colors made by three well-known glass manufacturers designated as X, Y and Z. The results are tabulated below, attention being called to the variation in range at which these were obtained.

RUBY.

Test No.	Size Lens, ins.	Roundel—Size, ins.	Make.	Distance, Miles.	Result.
1	5⅜	6¾	X	2.4	Good.
2	5⅜	"	Y	"	Very good
3	5⅜	"	Z	"	Fairly good.
4	4½	"	X	"	Good.
5	4½	"	Y	"	Very good.
6	4½	"	Z	"	Good.

GREEN.

1	5⅜	6¾	X	2.2	Fairly good.
2	5⅜	"	Y	"	Very good.
3	5⅜	"	Z	"	Very poor.
4	4½	"	X	"	Poor—dim.
5	4½	"	Y	"	Very good.
6	4½	"	Z	"	Fair—not distinct.

YELLOW.

1	5⅜	6¾	X	1.0	Good.
2	5⅜	"	Y	"	Good
3	5⅜	"	Z	"	Good.
4	4½	"	X	"	Poor.
5	4½	"	Y	"	Very good.
6	4½	"	Z	"	Poor.

As a photometric test was to be made to determine the comparative value in candle power of the one-day and long-time burner, it was not considered necessary to make any further test on this line. It was afterward thought advisable to make a range test through roundels, using standard semaphore lamps equipped with long-time burners with and without reflectors to ascertain if any difference could be detected.

This was done March 6, 1905, on a tangent 2.37 miles east of Sayre, Pa., during a heavy rainstorm. Three lamps were used, one equipped with 5-in. and two with 4½-in. lenses. They were first tested with and afterwards without reflectors through ruby and green roundels, the result being that in all cases, the light could be clearly defined but was stronger when reflectors were used.

PHOTOMETRIC TESTS.—The next point was to determine by photometric tests the value in candle power of various burners with and without lenses or reflectors. These were made between June 15 and July 10, 1905.

APPARATUS USED.—A photometer of the Lummer-Brodhun type, manufactured by A. Kruss, Hamburg, the bar of the photometer being 3 m. in length, graduated to 5 mm. and permitting of readings to 1 mm.

STANDARDS.—Three 16-c. p. incandescent lamps certified to by the General Electric Lamp Works, Harrison, N. J., standardized against their standard lamps (certified by the Physikalisch-Technische Reichanstalt, Charlettenburg, Germany). These three lamps required the following voltage respectively: 111.7; 112.8; 112.7. Against these standards was tested a 4 c.-p., 110-volt incandescent lamp which showed a photometric value of 4.192 c. p. at voltage 112.8 and 112.7.

Another lamp showing 0.59 c. p. at same voltage was also tested. The lamp with 4.19 c. p. was used as working standard in comparison with the burners and lamps, except in measuring very low intensities, when the incandescent lamp giving 0.59 was employed.

The voltage was controlled by rheostats—German silver coils with slides, furnished by the General Electric Co. Incandescent lamps were used in preference to an amyl acetate or pentane lamp, because the flames of such standards are too whitish in cast to permit of close comparison with the yellowish kerosene flame.

METHOD.—The flames and lamps to be compared were carefully levelled and centered upon the photometric screen. But it was noted in several cases when the lamp was tested that owing to the brightest part of the name being eccentric to the optical axis of the lens, the photometric reading secured was not so high as would have been the case had the lamp been tipped until the brightest part of the projected beam fell upon the screen. In making the series of tests with "long-time burners" as the flame burned longer, the position of the brightest part of the projected beam shifted, and if the flame was burning at the start with such combustion as to throw the brightest part of the beam too low with the decrease in the height of the flame, this error would be corrected and a higher reading secured even with a smaller flame, than was afforded at the start.

All flames were adjusted below point of smoking before making test. Long-time burner wicks were all trimmed and adjusted to a height of ⅞-in. by representatives of the different lamp makers before commencement of test. On the basis of these averages, the candle power was then deduced, preserving all figures to the third decimal place. In making these tests, where it was desired to obtain the relative value of different types, lamps furnished by the three manufacturers before mentioned were used and will be designated as A, B and C.

TEST 1.

An average one day burner, flat wick, naked flame: 1.48 c. p.

TEST 2.

Long time burners without reflectors; all burners removed from lamps, chimneys retained in place: A.—0.330 c. p. B.—0.281 c. p. C.—0.354 c. p.

TEST 3.

Long time burners with one way reflectors; all burners removed from lamps, chimneys retained in place: A.—

parabolic reflector 0.826 c. p. B.—spherical reflector 0.414 c. p. C.—spherical reflector 0.473 c. p.

TEST 4.

Long time burners, with one way reflectors in position in standard semaphore lamps equipped with lenses. (This included a series of tests made upon subsequent days until lamps burned out; the results of same are shown in table 1.) Lamp A equipped with a 4½-in. lens, 3-in. focus and one-way parabolic reflector. Lamp B equipped with a 5-in. lens, 3½-in. focus and one-way spherical reflector. Lamp C equipped with a 4½-in. lens, special (3½-in.) focus and one-way spherical reflector. On the first day, ten readings were taken in each case, two each by five different observers and the average then calculated, with the following results: A.—35.07 c. p. B.—16.92 c. p. C.—29.66 c. p.

TEST 5.

Value of a four-way reflector, lamp equipped with four 4-in. lenses, 2¾-in. focus, testing through a white lens. With a reflector, 19.60 c. p. Without a reflector, 18.43 c. p. Increase of efficiency by reflector, 1.26 c. p. or 6.8%.

TEST 6.

Comparative value of one day and long time burners in lamp equipped with a 6⅞-in. lens, 3¾-in. focus. One day burner, 70.15 c. p. Long time burner with one-way parabolic reflector, 45.62 c. p.

TEST 7.

Switch lamp equipped with one-day burner and 4½-in. lens, 3-in. focus, burner being at angle of 45° to axis of lens; 42.40 c. p.

TEST 8.

Comparative value of one day and long time burners in lamps equipped with 5⅛-in. lens, 3½-in. focus: One day burner, 51.8 c. p. Long time burner with one way parabolic reflector (23 hours after lighting), 40.3 c. p.

NOTE.—The following comparison of the efficiency of different sizes of lenses may be of interest:

Lens focus, ins...	2¾	3½	3	3½	3½	3¾
Diameter, ins.....	4	4½	4½	5	5⅝	6⅜
One-day burner without reflector, c. p.....	19.60	.....	42.40	.....	51.8	70.15
Long-time burner, one-way reflector c. p.....	.....	29.66	35.07	24.30	40.3	45.62

The result obtained in the two duration tests are given in the following table with the recommendation that Table II be considered as the most accurate for the reasons that when the lamps were first prepared, it was not understood by all that the same was to be continued as a duration test and only 16 oz. of oil was put in each cup; the low candle power of lamp B on first reading, evidently due to same not being in focus and not being able to account for the sudden drop on June 16. When second test was made, each lamp was given 20 oz. of oil and flames adjusted to the height of ⅞-in. The results of this test are also shown graphically on appended chart. Lamp A equipped with 4½-in. lens, 3-in. focus, one-way parabolic reflector. Lamp B equipped with 5-in. lens, 3½-in. focus, one-way spherical reflector. Lamp C equipped with 4½-in. lens, special (3½-in.) focus spherical reflector.

After making the above tests, the Adams & Westlake Co. submitted a lamp equipped with a 5⅛-in. lens, 3½-in. focus and a glass reflector, requesting that a photometric test be made in comparison with a one-day burner. This was made with the following results: One-day burner 51.90 c. p.; long-time burner 48.04 c. p.

A range test was also made comparing it with a parabolic reflector; two lamps, placed 13 ft. apart, merged at a distance of 1¼ miles. At one mile, they could be distinguished separately; the one having the glass reflector gave a clearer and more sharply defined light, whiter in color, with the beams spreading farther. At a distance of two miles (the limit of range) the lamp equipped with glass reflector gave a much larger and clearer indication than any others tested, its efficiency being best illustrated by using an expression of one of the trainmen present: "It shows up like a headlight."

ILLUMINATING OIL.—BRAND BEST ADAPTED FOR LONG TIME BURNER; ALSO COMPARISON OF THE QUANTITY CONSUMED BY THE ONE DAY AND LONG TIME BURNER.

Considerable difficulty has been experienced in collecting data on this subject as the present specifications for illuminating oil used by various roads will not in all cases meet the requirements. While some brands are acceptable, they contain certain properties not adapted to the long time burner. In conversation with a representative of the Standard Oil Co., he asserted that in filling orders, they aim to meet the specifications, which heretofore have given satisfaction for one day burners, the principal reasons for not giving good service for the small flame being moisture in the oil and the presence of impurities by using barrels which had previously been filled with other grades of oil. To overcome these objections, he recommended that a specification be prepared for oil specially adapted for these burners. A series of tests are now being conducted for this purpose and if possible, results will be given at this meeting. From a number of specifications received for illuminating oil the following was selected as a fair example.

TABLE I.

Lamp.	June 15 2-3 p.m.	June 16 3.30-4.30 p.m.	June 17 4.30-5.30 p.m.	June 18	June 19 9 a.m.	June 20 5-6 p.m.	June 21 2 p.m.
	c.p.	c.p.	c.p.	c.p.	c.p.	c.p.	c.p.
A	35.07	30.84	25.26	Repairs to Dynamo prevented test	Out at 5 a.m. 8.53, out at 6 p.m. 2.43	1.27	Out at 3.30 p.m. .008
B	16.92	24.30	9.62				
C	29.66	22.58	7.73				

TABLE II.

Lamp.	July 5 10.30 p.m.	July 6 4.15 p.m.	July 7 4.15 p.m.	July 8 4.15 p.m.	July 10 9 a.m.	July 10 5.30 p.m.	July 11 4 p.m.
	c.p.	c.p.	c.p.	c.p.	c.p.	c.p.	c.p.
A	33.36	28.54	27.70	26.66	24.35	27.96	3.02, out at 9.10 p.m.
B	21.42	24.27	24.14	21.96	Out at 7.50 a.m.	12.24, out at 10.45 p.m.	
C	21.00	21.46	17.62	21.80	17.18		

PETROLEUM ILLUMINATING OIL.

150 DEGREE OIL.—Sample must not flash below a temperature of 100° F., nor burn below a temperature of 150° F., when heated at the rate of 2° per minute.

Must be of a color of not less than plus 25 on Saybolt Universal Chronometer and remain clear and transparent when cooled to a temperature of 0° F. and held there for 10 minutes.

It must not have a higher specific gravity than .7999 (nor less than 47° Baumé).

All samples to show a neutral or slightly alkaline reaction. A sample will be taken from each carload, or part carload lot (either in bulk or in packages), and such sample shall be considered representative of the entire shipment.

All samples will be taken with a thief.

The cup used for determining the flashing point will be the Elliot closed cup or N. Y. State standard.

Any sample failing to meet all the requirements of this specification will be condemned and the shipment represented by it will be returned to the manufacturers at their expense, they paying for freight both ways.

Experience has proven that of the various brands received on above specifications, the best results have been obtained by using brand known as "Crystal White," a Pennsylvania product, no trouble being experienced by the wicks crusting as the carbon which forms will harden and disintegrate, thereby allowing free combustion, no smoking of chimney or sediment collecting on wick, thereby preventing a free flow of oil and maintaining a clear full flame for a period varying from four to six days.

A comparative test of amount of oil used between the one day and long time burner was made during the month of February, 1905. Six fonts, each containing 12 oz. of oil, equipped with one day burners were placed on test; the time required to consume this oil varied from 18 to 20 hours, the average being 19 hours. Another test was made with nine lamps equipped with long time burners, each foot containing 16 oz. of oil, the time required to consume this varied from 112 to 180 hours, the average being 160 hours. Another test same as above with 8 lamps, the average time consuming 16 oz. oil was 140 hours. The general average of the two latter tests being 150 hours. In the first and second test, Crystal White oil was used and no crusting of wicks was experienced. In the later test, another brand of oil was used—one flame out at 105 hours, another at 136 hours, all wicks crusted. These tests were made on a balcony of a building about 35 ft. above ground. Temperature ranging from zero to 20° F. above with high winds at times. No light was found to be blown out during the testing period.

As to the economy in using long time burners, below will be found a statement showing the material and labor charges on a Division having 171 miles double and 158 miles of single track. This is taken from records during the last twelve months one day lamps were in service and compared with the last fiscal year, long time burners being in use.

MATERIAL.

Kind.	No. Lamps	Oil, Gals.	Wicks, Gross.	Waste, Lbs.	Burners.	Chimneys.
One-day	893	17,690	36	1,789	411	...
Long-time	817	8,141	11	581	98	438

COMPARATIVE COST.

	Material.	Labor.	Total.
One-day burner.....	$1,991.11	$14,534.96	$16,526.07
Long-time burner.....	900.28	7,072.30	7,972.58
Amount saved by use of long-time burner.....	$1,090.83	$7,462.66	$8,553.49
Average cost per annum—one day burner.....			$20.58
Average cost per annum—long time burner.....			9.76

MAINTENANCE OF LAMPS.

Relative to the maintenance of lamps, past experience has developed the fact that as a rule they have not been given the attention due them, a sectionman or a cripple being assigned to look after them with no one directly responsible for their proper care, the general result being that they are dirty, wicks improperly adjusted and uneven flame causing the smoking of lenses and lamp, the accumulation of soot and dirt interfering with ventilation. In order to get best results, the lampman (whose duties should be to maintain lamps only) should come directly under the charge of the Signal Supervisor or a person directly in charge of signals. He should be instructed as to his duties and if a report of a "light out" is received, he should be sent to relight it. After doing this a few times, he will take more interest in his work in order not to be called out at night. Where long time burners are used, one man can readily cover 15 miles exclusive of large yards. Instructions should be issued covering the duties of lampmen, the most important being listed below:

To cover their district at least twice a week.

Lamps, lenses and reflectors, where used, to be thoroughly cleaned, removing all accumulation of soot or oil. Soft paper to be used in preference to cotton waste or cloth in cleaning lenses and reflectors.

All ventilation to be kept free of obstructions.

Where chimneys are used, see that they properly fit the holder and are perfectly clean.

The burner to be occasionally boiled in water and soda to cleanse thoroughly and remove all gumming which is inevitable with any style of signal burner.

Care to be taken to see that cup or font of proper height is used in lamp.

Fonts to be filled within ⅝-in. of top. After 30 days service, all oil remaining in fonts to be emptied and all sediment removed before refilling. The oil taken from fonts to be sent to (place to be designated).

Wicks to be scraped (not cut) with the back of a knife or other instrument and after lighting same, to remain until flame is properly adjusted as it will increase as oil becomes heated. Care to be taken that flame does not smoke.

Remove wicks every 45 days.

Draw off all oil in tanks before refilling and clean the same of all impurities. Make a study of the lamps with a view of correcting any irregularities that may arise.

CONCLUSIONS.

The design of a signal lamp should be such as will meet the exacting requirements of a present day railroad service. The question of steel construction is accepted as the most desirable, the point at variance being the system or method of ventilation. From experience and tests made, the top draft system is recommended for the following reasons:

(1) The maximum signaling power of the lenses is secured at all times regardless of the variations in temperature, as no moisture, frost or ice will collect upon the lenses and retard the passage of light.

(2) The destruction of the lamp through corrosion is reduced to the minimum, as no moisture is formed through precipitation on the interior body of the lamp. Prior to the introduction of this top draft system of ventilation, it was found that the precipitation of moisture on the interior of the lamp was one of the most potent causes for the destruction of lamp bodies. It is not so much the precipitation of moisture during one night that counts, but the continued action of this kind, which starts corrosion, and when corrosion has once started, the action is assisted very materially by this continued condensation of moisture or "sweating" which means that the lamp body will rust through and be destroyed much earlier than in the case of a lamp equipped with top ventilation. This is of especial importance as tending to increase the life of the lamp, and materially reduce the cost for replacements and repairs.

(3) And of equal importance with the results mentioned above, is the fact that a lamp equipped with this system of ventilation burns equally well under all atmospheric conditions, i. e., it will not become overheated or choked out in sultry weather when there is no movement of the outside air, nor will it blow out in the highest winds.

This draft arrangement produces perfect combustion by furnishing a constant supply of fresh oxygen to the flame, and at the same time, immediately carrying upward and out of the lamp all combustion gases.

It will be noted from the description of this system given under "Design and Construction of Lamps," that the fresh air is drawn into the lamp through the small holes near the top of the body, while the hot air, carrying all products of combustion, passes through the large flue in the center of the lamp, whereby rapid and unobstructed egress is provided for the hot air, while the cold air is drawn in to replace it, thus forming a perfect system of balanced draft.

While the results mentioned above are of the highest importance in all types of signal lamps, yet they are of especial importance in a semaphore lamp. In other systems of ventilation much difficulty has been experienced with semaphore lamps on account of the moisture, frost and ice which would collect on the inside of the lenses and retard a certain amount of light, and as the light from a semaphore lamp is required to penetrate the roundel in a semaphore arm, a defect of the nature mentioned above becomes especially noticeable and dangerous where frequent high speed trains are operated.

Relative to the comparative value in efficiency and candle power between one day and long time burners: In view of the fact that there is a doubt in the minds of some as to the efficiency of the small flame of the long time burner, it might be well to state that in all tests made, the lenses were completely filled, showing that the volume of light is sufficient to meet the requirements.

It will be noted that in testing long time burners, the flames were adjusted to the height of ⅞-in. This was done in order that all lamps would have an equal test. In ordinary use, however, this can be increased to the smoking point, in some instances the height of 1⅛ ins. can be reached. The results obtained in tests may be summed up as follows:

(1) That a long time burner in a switch lamp without reflector and on a semaphore lamp with reflector placed back of either a ruby or green roundel cannot be run down in a distance of over two miles and at this distance displays a good efficient signal; also a yellow roundel can be readily distinguished at a distance of one mile, clearly demonstrating that it is safe to use this for one of the night indications. In the range test, the lenses and roundels used were selected at random and were not of a uniform color as it was not the intention

to test the quality of glass, but rather to obtain results from actual conditions as they exist.

(2) In the photometric tests made, the value of a one way reflector is clearly shown, whereas in a four way, the increase in candle power is but 6.8%, which does not warrant the expenditure necessary for its use. Particular attention is called to the increase in candle power where the larger lenses were used. The results shown in table 2 prove conclusively that the long time burner will give efficient service for a period of four days. Especially is this true if the glass reflector is used, as this shows an increase of 14.68 c. p. over the parabolic which tests prove is superior to the spherical.

(3) Referring to the question of reflectors as applied to semaphore lamps, it is generally known that a lens is constructed to a focus, and so made as to pass the rays of light coming from this focus into a parallel beam. Any rays of light not coming from the focal point are, generally speaking, not sent along the parallel line, but pass off at an angle.

In regard to the effect of a reflector, if it is so constructed as to receive the rays of light going into the body of the lamp and so lost to the lens, and reflects back through the focus, there will, of course, be just that much more light sent through the lens, and since it passes through the focal point, it will pass out into the parallel beam and proportionally increase the efficiency of the lens. If, on the other hand, the reflector simply throws the light into the lens without reference to the focus, these rays will be diffused, and the total effect, so far as they are concerned, will be the same as if the lens was not focused properly. In other words, there would be more light on an angle, but the efficiency of the lens, so far as the parallel column of light is concerned for which it is designed, would not be otherwise affected.

The glass reflector has been constructed with an especial view to gathering up the rays of light that would otherwise go into the body of the lamp, and throw them back into the focal point of the lens, thus materially increasing the volume of light sent through the lens, passing out into the parallel beam, and increasing the efficiency of the lens.

As previously stated, the question of illuminating oil for long time burners is such that the greatest care should be taken in procuring a grade adapted to this burner. It has been found that oil in barrels exposed to the weather will collect moisture, at the same time it has been noticed that later shipments have been used simply because it was more convenient to ship than to use that which had been on hand for some time, which is a mistake as oil is not an article that will improve with age. The supply must be watched carefully and only a limited amount kept on hand. If possible, as soon as received, it should be sent to the lampmen and emptied into metal tanks provided for this purpose which must be kept clean and free from all impurities.

Relative to the economy in the use of the long time burner, it will be noted in statement previously shown that there is a saving of over 50% in labor and material which in itself should commend its adoption.

The question of selecting men for the position of lampmen is one that should be given serious consideration, as upon their vigilance depends the efficiency of night indications. These men should be educated to make a study of the lamps in their charge and the conditions affecting same with a view of anticipating trouble. They should also be given to understand that when an opportunity presents itself, they will be in line for promotion, if their services have been satisfactory.

Before closing this report, it is recommended that the thanks of the association be extended to the Adams & Westlake Co., Dressel Lamp Co, and the Armspear Manufacturing Co. for the generous support given in obtaining the results embodied herein; also Mr F. E. Wass, a member of this committee, for his untiring efforts in giving his personal attention in conducting the various tests.

MUNICIPAL IMPROVEMENTS IN PROGRESS AND PROJECTED AT MANILA, P. I.

By J. F. Case,* M. Am. Soc. C. E.

The scheme of public improvements for the City of Manila comprises the expenditure of approximately $6,000,000 within the next four years, and opens a field of interest to contractors in general. The largest items are for the construction of a new sewer system and a gravity water supply, proposals for which will be received in January next. (See Proposal advertisement elsewhere in this issue.—Ed.)

The financial condition of the city is rare and worthy of comment. With a population of nearly a quarter million, and with an assessed valuation of nearly $45,000,000, the city has no indebtedness whatsoever, except that incurred by the sale of the first installment of the funds for the sewer and water-works construction. The total issue authorized for this purpose is $4,000,000, of which amount $1,600,000 has already been sold to provide funds for beginning the work. A premium of 10% was realized on those bonds.

The adopted plans for sewers provide for a separate system, and no provision has yet been made for storm water drainage. The plans, in general outline, provide for starting the sewers at their upper ends, as near the surface as possible, and obtaining the necessary grade by increasing the depth thereof until the economical limit is reached. The sewage is then raised by pumping and the process repeated until the main station is reached, whence all sewage is finally disposed of by pumping seaward into the bay. The total estimated cost is about $2,000,000.

The plans for the water system provide for impounding the waters of the Mariquina River, a mountain stream, at a point some sixteen miles from Manila, and conveying the same by means of a steel riveted pipe and masonry conduit to the distributing reservoir in the environs of the city. The present distribution system will be utilized as far as possible, but large extensions will be necessary, though not at present under contract.

Aside from the sewer and water system there are at present under contract three bridges, aggregating in cost $125,000, and three sections of the Pasig River wall, aggregating $310,000.

In contemplation or preparation there is the improvement of the esteros or canals, whose ramifications extend throughout the city; the installation of a system of storm water drains; further construction of Pasig River walls, and a large amount of street construction and paving. The Insular Government will also receive bids early in the coming year for the construction of new steel wharves in the recently completed harbor.

Since the attention of contractors and material men may well be drawn to this field for enterprise, it is believed that a short description of conditions here may be of interest.

Climatically the year is divided into two seasons the dry, from December to May, and the wet, from June to November, both inclusive. During the dry months out-door work may be carried on without interruption, while the wet months will interfere more or less with work on low grounds, trenching, or control of streams. The average rainfall is about 75 ins. per annum, of which amount about 80% falls during the wet months. Out-door work, however, is not by any means suspended during these months, since precipitation is not constant and many days without rainfall of importance are interspersed.

As regards health, Manila need not be feared. The death rate among Americans and Europeans is low and, excluding infant mortality, the total death rate is not excessive. The most important question to intending employers is that of labor, and some diversity of opinion exists and is expressed. The views herein set forth are those of the writer, deduced from more than seven years' experience with the native laborer, not only in Manila but also in the provinces.

The native is of less robust physique than the American, and is consequently less efficient. He is also satisfied with earnings only sufficient for his immediate needs, and therefore after pay day does not care to work until his money is expended. Left to himself, he is prone to carelessness in his food and may easily be either underfed or poorly nourished. On the other hand, he is tractable, quiet, and sober, and his daily wage averages less than half that of an American. The best results can be obtained by a sort of paternal supervision on the part of the employer, and this supervision must extend not only over the working hours but throughout the entire day. Attention to housing, feeding, sanitation and amusement will surely result in increased efficiency, cheerfulness and disposition to work, while small concessions made to those who complete the full number of working days per week will secure less unnecessary absences from work. As a rule, time books and pay rolls will show 25% more names of men employed than are actually at work on any given day, but a process of elimination will finally secure a very satisfactory working force. Patience, justice and instruction are indispensable and skilled supervision is a prime requisite. Each foreman must be able to instruct and excel in every branch of the work under his charge. Skilled labor in the American acceptation of the term is somewhat scarce, but the native is imitative and quite adaptable. Machinists and artisans of more or less skill are numerous, and where it is possible to keep a man on one particular class of work he soon becomes fairly expert. During the building of the new harbor works Chinese and negro labor was tried, but in a comparatively short time was eliminated, for the native had proven himself more satisfactory and economical. This work comprised timber work, pile driving, quarrying, ship building, masonry and concrete work, iron and steel erection, dredging and kindred construction, and the natives proved themselves capable, not only in ordinary labor, but as stationary engineers, and in handling pneumatic tools, running derricks and other work which is considered as skilled. The installation of the new electric street railway system was accomplished satisfactorily with native labor entirely, and this included excavation, track laying, ballasting, concrete work, paving, installing machinery, and reinforced concrete building construction.

It is the belief of the writer, borne out by carefully kept cost tables, that the native laborer, properly treated and cared for, will compare favorably in economical results with foreign competitors.

Another point of interest to the contractor is the consideration of Manila as a supply and repair depot. The Archipelago is open to the competition of the world and nearly every nation is represented in its trade. English, German, French, Swiss and Spanish goods, as well as those from the United States, are on sale. Fair stocks of tools, implements, etc., are carried, but large orders for supplies are generally placed with agencies for importation. All governmental purchases are made by the Insular Agent. There are several fairly well equipped machine shops in the city, including foundries for brass and iron castings of ordinary size. Unusual tools for special work would need to be imported. Cements of various brands are either in stock or can be quickly secured. Both American and European brands are in use, but the local trade is generally supplied with that of Hong Kong or Japanese manufacture. For transportation there are several teaming and trucking firms, supplied with American or Australian horses or mules and American wagons, carts and trucks. Probably one hundred teams could be secured at a daily rate but little higher than is paid in the western part of the United States. Bar and flat iron is carried in stock, but rolled shapes, except in small sizes, would have to be imported. Two of the largest contracting firms in the United States are already established here and both seem fully employed. There are also a number of firms and individuals who compete in works of less magnitude.

While these notes refer solely to the works in the City of Manila, attention might also be invited to a large amount of improvements contemplated by the Insular Government throughout the Islands, as well as to the general scheme of railroad construction now under advertisement.

Interested visitors will find the months of November and December best for seeing conditions here, as they will be able to observe the close of the rainy season and the beginning of the dry.

Regular lines of steamers sail at frequent intervals from San Francisco, Seattle and Vancouver, either direct or via Hong Kong.

*Chief Engineer, Department of Sewers and Water-Works Construction, Manila, P. I.

SEWAGE CONTACT BEDS DECLARED SUPERSEDED BY PERCOLATING OR SPRINKLING FILTERS.*

By Prof. Bostock Hill.

I am strongly of opinion that contact beds are unscientific. Their adoption enabled us to experiment with bacterial methods in various ways, and has by a process of evolution allowed us to determine their limitations and their deficiencies, but I firmly believe that contact beds as a system for sewage resolution and purification are dead, and will in future only be interesting as a matter of history. In saying this, however, I do not wish to be misunderstood. I am quite aware that there are excel-

*From a paper read recently before the British Association of Managers of Sewage Disposal Works.

lent results being produced at the present time in many places by contact beds. In the county of Warwick I know of one of the best sewage works, producing continuously a good effluent, in which contact beds are used, but I cannot help feeling that if the same works had been laid down three years later, contact beds would not have been used, and I find that in all the schemes which come before me at the present time engineers almost exclusively rely upon tanks for resolution, and streaming beds for oxidation.

I propose, therefore, to consider shortly some important points in connection with works of this description, and first of all as to the resolving tanks. It is important, I think, that these tanks should be of sufficient size, and the point naturally arises: What is a sufficient size for a particular sewage? This, I think, can generally be determined at about a 24-hours' flow, but there may be exceptions in particular sewages where a longer or shorter time is necessary. In most instances, however, if a shorter period than 24 hours is taken, then there will be a considerable risk of too much suspended matter coming over in the septic effluent, and I believe that the main object to be striven for in the treatment of the septic effluent is to get the proper degree of resolution, together with the smallest amount of matter in suspension. The next point worthy of a moment's consideration is the supply of the septic effluent to the filter beds, and I think a word of warning will, perhaps, not be out of place here. It is undoubtedly desirable to supply the filter beds with sewage in as fine a degree of division, and therefore of aeration, as possible, and consequently in many instances at the present time arrangements of fixed sprayers have come into use, by means of which the sewage is sprayed into the air and falls like rain on the surface of the filter bed. This scheme, which was first put into use at Lichfield, has been followed in more or less modified form at Salford, Chesterfield, and other places. Provided the sewage is subjected to preliminary treatment of precipitation by means of which offensive matter is removed, and the sewage itself is not made putrescent, then I think a fixed sprinkler has marked advantages over other forms of distributors, but if the filter beds are to receive the sewage from resolving tanks, and are not far removed from roads or human habitation, experience shows that there is considerable danger of nuisance being produced, particularly in the autumn when trouble of this kind becomes accentuated owing to climatic conditions. We must not forget that at Chesterfield an injunction has been obtained against this method of supplying tank effluent to the filter beds, the complainant being, I believe, at a distance of 500 yards from the bed; while I myself have had personal experience of the fact that the fine spray produced is at times carried considerable distances, causing a nuisance. No doubt much for this reason the most generally used form of distributor is a circular traveling one, working by the head of sewage or by some mechanical power, and though there is much difference of opinion as to which of the many types on the market give the best results, I think at the present time opinion is veering towards one in particular as being the most satisfactory. This, however, is more a question for engineers than for me, but it must not be forgotten that the use of this form of distributor necessitates a circular filter, and that a circle is of less area than any figure of the same diameter, and the use, therefore, of circular filters is apt to be wasteful and at times inconvenient.

COLLOIDAL MATTER IN SEWAGE EFFLUENTS.

An apparently important factor in sewage treatment which has as yet received but little attention is that portion of the suspended matter which is in emulsion; or to be more chemically exact, colloidal matter. Such suspended matter, in untreated or in newly treated sewage, is not visible and is unaffected or but little affected by sedimentation or by filtration. After the sewage or effluent stands and oxidizes, the colloidal matter separates. It may then, under certain conditions, give rise to troublesome putrefaction. An interesting paper on this subject* has been sent to us by Dr. Gilbert J. Fowler, one of the authors. The paper is based largely on studies made by Dr. Fowler at the Manchester Sewage Works, but contains very brief references to some German studies.

The authors classify suspended matters in sewage as follows: (1) Floating matter and detritus, which may be screened out; (2) finely disseminated solids, a large percentage of which may be removed by sedimentation; (3) "matter in emulsion or colloidal matter," which cannot be removed by settlement.

Speaking of colloidal substances in sewage, the authors of the paper say:

> It is obvious that the work to be done by filters is largely conditioned by the amount of colloidal matter, as this represents potential suspended matter.
>
> Exact knowledge as to the nature of this colloidal matter is at present wanting.

The amount of colloidal matter present in sewage and effluents can be determined by gathering it on parchment; or, in other words, by dialysis. Various determinations of this kind are reported in the paper under review.

It is possible, but impracticable, to largely reduce colloidal matter in sewage by means of chemical precipitation.

An open septic tank effluent contained colloidal matter, apparently in slightly greater quantity than an effluent from a plain settling tank. Effluents from primary contact beds also contain colloidal matter; undoubtedly this is of a different character than that from untreated sewage and from septic tanks, but the exact difference cannot be stated without further experiments. Continuous or percolating filters yield effluents containing "suspended matter in a granular condition," which on incubation in absence of air shows "sufficient organic matter to become putrefactive." The authors seem to think it probable that both the suspended matter and its possible noxious character increase with the age of continuous filters.

They state that while continuous filters of "fine grade" may yield effluents free from suspended matter, yet "a certain amount of accumulation is ultimately bound to take place in the bed."

By way of summary the authors say:

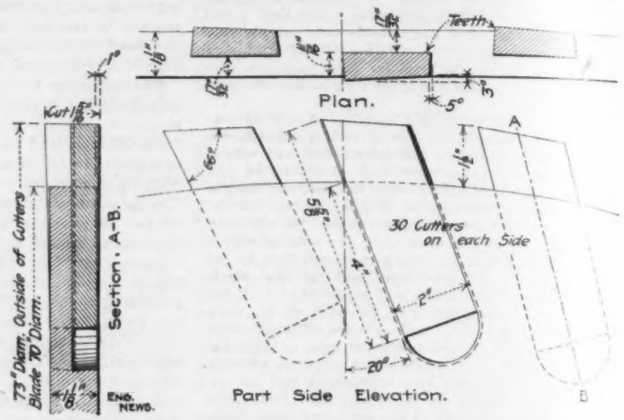
> In addition to the ordinary sludge obtained by settlement of the sewage, the sewage chemist is faced with the disposal, ultimately, of the residue left after transformation of the colloidal matters in pseudo solution or emulsion.
>
> Experiments are in progress, in order to determine what proportion of these can be actually oxidized by bacterial activity, and what proportion will have eventually to be dealt with and removed from the filtering medium by washing or screening.

In the discussion which followed the reading of the paper, Mr. E. Halliwell, of Preston, England, stated that effluents from continuous or percolating filters contain variable quantities of suspended matter, which must be removed because a large proportion of it is organic. At first the suspended matter is small, but later it "in many cases would average about 10 parts per 100,000." The amount is still larger when the revolving sprinkler arms are sometimes stopped by the wind or otherwise [fixed sprinklers are sometimes used.—Ed.]. The main part of the suspended matter in effluents from continuous filters comes directly from the [septic ?] tank. At Nelson about 1 part of sludge to 1,000 parts of sewage, by volume, the sludge containing 6% of solid matter, was deposited from the effluent of sprinkler filters."

*"Suspended Matter in Sewage and Effluents." By Gilbert John Fowler, D. Sc., and Edward Ardern, M. Sc., was printed in the (British) "Journal of the Society of Chemical Industry" for May 15, 1905, and has since been reprinted for the authors. Dr. Fowler was formerly Chemist and Superintendent of the Davyhulme Sewage Works, Manchester, England, and is now Consulting Chemist to the Manchester River Department, which has charge of the sewage works (since November, 1904, three in number) of Manchester. Dr. Fowler's address is Broad Oaks, Urmston, near Manchester, England.

HIGH-DUTY COLD SAW WITH TEETH OF HIGH-SPEED STEEL.

A special design of high-duty circular saw which enables high-speed steel to be used for the teeth has been designed for cutting steel castings and forgings, structural steel, armor plate, etc., and is illustrated herewith. The blade is a disc of high-carbon crucible steel, and is of sufficient stiffness to withstand any pressure that can be safely put upon the teeth. In each face there are slots for the teeth, and the slots are inclined backward from radial lines at such an angle that the pressure on the teeth when cutting has a locking effect; as the resultant of the pressure tends to force the teeth inward, and as there is no tendency to draw them by the cut, the teeth do not require to be pinned or bolted or otherwise fastened in place. The teeth are of simple design, forged from the bar stock in a plain die. As no machine work is required to shape or fit them, the teeth can be made of the modern high-speed steels, while in saws where the teeth have to be drilled, shaped, etc., ordinary tool steel has to be used and tempered. It will be seen also that this saw has the special feature of dividing the cut, the teeth being placed (in staggered position) on each side of the blade and slightly overlapped, so that each tooth alternately takes half the width of the cut. The teeth have a slight outward in-



HIGH-DUTY COLD SAW WITH TEETH OF HIGH-SPEED STEEL.

clination, so as to make the cut clear the saw blade, the points of the teeth being the only part of the saw which touch the work. A broken tooth can be quickly driven out by a chisel inserted in the semicircular recess at the bottom of the slot, and a new tooth at once put in its place.

The saw shown in the accompanying cut is one of 73 ins. diameter for an armor-plate cold sawing machine for the Midvale Steel Co. The blade or disc is 70 ins. diameter and 1⅛ ins. thick, with 30 teeth on each side, the teeth being inclined 20° back of the radial line, and having an outward inclination of 1°, so as to make a cut 1 5-16 ins. wide. The teeth are of a special grade of steel made by the Midvale Steel Co. and have an angle of 60° for their cutting edges. A 5-in. nickel-steel plate (unhardened) has been cut with a feed of 40 ins. per hour, while a 4½-in. hardened steel armor-plate has been cut with a feed of 9 ins. per hour. The blade is bolted to a collar on a mandrel, and the machine is directly geared to a 50-HP. electric motor, change gears giving six peripheral speeds of 10 to 40 ft. per minute.

These saws are made by the Tindel-Morris Co., of Eddystone, Pa., and we are indebted to Mr. Adam Tindel, President of the company, for plans and other information. At the company's works they have been in use for over three years without any cost for repairs. With machines of sufficient power for the work, feeds of ½-in. to 1¼ ins. per minute are used on castings, forgings, bridge pins, structural steel, and other material in which the carbon does not exceed 0.40%. The peripheral speed for the same kind of material is about 50 ft. per minute.

THE SUIT OF THE CAMERON SEPTIC TANK CO. against the village of Saratoga Springs for alleged infringement of the Cameron, Commin & Martin septic tank patents has progressed to the point of completion of testimony by the defendants. Since the case was brought in the U. S. Court the defense has been extended to include the cities of Madison, Wis., Monmouth and Lake Forest, Ill., and also the Allis-Chalmers Co., of Milwaukee. The leading experts for the defendants have been as follows: Mr. F. Herbert Snow, of Snow & Barbour, Boston, has reviewed the history of the art; Mr. Wm. S. MacHarg, of Chicago, has testified regarding intentional prior use of the septic tank, as also have Prof. A. N. Talbot, of the University of Illinois, and Mr. Benezette Williams, of Chicago; a final review of questions relating to prior users and to the history of the art has been given by Mr. John W. Alvord, of Chicago. The plaintiffs will now introduce their evidence in rebuttal. The hearings have been and will continue to be held before a Master, in New York and in Chicago. Both parties to the case state that they are trying to expedite the case so that a decision may soon be reached.

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"Want": See pages 26 and 27.

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Entered at the New York Post-Office as Second-Class Matter.

An editorial article in our issue of June 1 has been quite widely and often carelessly quoted. In the editorial we called attention to the fact that at the time of the last U. S. Census some 40,000 engineers were practicing their profession in this country, and that at least 15,000 students were at the same time preparing to enter the engineering field. Our main conclusion from these facts was that the majority of young men now studying to be engineers must eventually find positions requiring fully as much knowledge of business as of engineering, and that our engineering colleges should recognize this by giving their students better training in business methods.

In spite of the distinct statement that we do not regard the field for engineers as being limited, we have been misunderstood by some readers.

It is true that the engineering profession seems overcrowded, and in a sense it is—but only when a narrow meaning is given to the word profession. If we restrict that term to those who are engaged in designing structures and machines, then it is true that the engineering profession is jammed to suffocation. But if we give the term its broad significance—if we include not alone the men who design engineering works but also the men who make, mold and transport materials, then we must concede that the engineering profession is not now, and never will be, overcrowded. Those who feel, as so many do, that an engineer is demeaning himself if he goes into manufacturing, or other pursuits, sometimes grouped under the comprehensive term of "business" seem to forget the broad definition of engineering, the one we are all so apt at quoting, but whose significance we are so likely to forget: "Engineering is the art of directing the great sources of power in nature for the use and convenience of man."

While we are on the subject of demand and supply in the engineering profession, we think it worth while to note that at present, so far as our observation goes, engineers as a whole are better employed, and we believe at more remunerative rates, than at any time for a long period of years. Of course, for every desirable situation there are a multitude of applicants; but it will be found that the great majority of these applicants are not men "out of a job," but those who are looking for an opportunity to better themselves. There appears to be a particularly active demand, moreover, for men who can "do things" and who have proved their ability to do things by their past accomplishments. Of course this time of active demand cannot be expected to be permanent. A season of dull times when new enterprises, on which engineers find their chief employment, are at a standstill for lack of capital, will doubtless follow, sooner or later, the present period of business prosperity. When that time comes it will be again a case of "the survival of the fittest," and a good many men who have gone into engineering because of the active demand for men, but with a minimum of actual fitness for the work, will find themselves dropped from the payroll and new positions hard to procure.

Nevertheless it is to be recorded that the passing of each decade sees a great advance in the number of engineers whose employment is permanent, who are brought into an enterprise not only for construction but for operation. As industry grows more and more complicated, the service of the experienced expert becomes more and more essential, and there is greater appreciation by the public of the value of such service. We have but to look at the great army of educated engineers engaged in a multitude of industries to-day and recall the mere handful of men who made up the American engineering profession of a half-century ago to understand the broadening that has come in the engineer's opportunity.

After the two preceding notes were in type, we received from Prof. Wm. Kent of Syracuse University the very interesting paper on demand and supply in the engineering profession, which is printed in full on another page of this issue.

The reader of Prof. Kent's paper will find at its outset the statement that "in 1903 nearly every engineering college in the country had applications for about twice as many graduates as it could furnish," and that in that year and also in the present year the demand for engineers exceeded the supply.

Is this correct? Are enterprises anywhere at a standstill because educated and experienced engineers cannot be had to carry on their technical work? We must confess that we do not know of any such enterprises anywhere. Is it not a fact, moreover, that a comparison between the number of current applications from employers to an engineering institution and the number of men in its graduating class is an unsound basis on which to found any broad generalizations? It is our impression that the employer who notifies Syracuse that he can give positions to say half a dozen young graduates, is likely to send the same notification to Cornell and Rensselaer, and perhaps other institutions in Central New York; or, if geographical considerations are not important, he may send applications to a dozen or more schools.

The youth who is debating whether he shall spend four years in an engineering school, should not form the idea from Prof. Kent's statement that there are good places open for twice the engineers that the colleges can grind out. He will find that the engineering profession is a place of keen competition, a competition which has for years kept down the returns from strictly professional work to a point that has caused a large proportion of those who were formerly engaged in that work to turn aside into business ventures.

The city of Philadelphia has the credit, we think, of officially recognizing first of any American city the necessity of providing regulations for the use of concrete blocks as a building material. As explained in another column of this issue, the Bureau of Building Inspection of that city has established recently a complete code of rules for the manufacture, testing and use of hollow concrete blocks to be employed in building work under its jurisdiction. Previously New York City had made a partial endeavor in the same direction, but with the idea in mind of covering by a sort of blanket specification all materials other than brick or stone rather than of covering specifically any particular material or materials. This appears to have been an error in judgment, at least in so far as hollow concrete blocks are concerned. The Philadelphia tests show conclusively that a building unit differing so radically from a common clay brick in dimensions and distribution of material as does a hollow concrete block, cannot be judged on the basis of test results attained from common brick. It is fortunate for those interested commercially in hollow concrete block construction that this fact has become published in so authoritative a manner; it would have taken a long time and a large amount of money for individual effort to have brought about a corresponding revolution of officially established conclusions.

The principle of the Philadelphia rules is that material will be judged on full size block tests and not on sample tests. It is rightly assumed that the strength of a building unit of comparatively complex form like a hollow building block, is not truly represented by a solid prism or cube cut from any portion of that unit. Tested in full size units, concrete blocks selected at random from Philadelphia makers' yards showed a modulus of rupture of from 150 to 175 lbs. and an ultimate compressive strength of 1,200 to 1,600 lbs. These figures, it should be noted, are obtained by considering the area under stress as the total area including hollow spaces and not as the area of solid materials above. The allowable stresses specified in the code come well below these obtained results, being for modulus an average of 150 lbs. and a minimum of 100 lbs., and for compressive resistance an average of 1,000 lbs. and a minimum of 700 lbs. It is desirable to bear these figures in mind, since they are likely for some time to mark the standard of excellence by which hollow concrete building blocks will be judged by architects and builders generally. In conclusion it is but right that the Philadelphia building authorities should receive hearty praise for their timely recognition of an important new building material and for their attempts to place its use on a conservative and scientifically safe basis.

The contractors for and owners of cheap buildings in Chicago seem to have combined with the dealers in tile pipe to resist not merely the establishment of a plumbing code requirement for cast iron soil and house drain pipes, but even such restrictions on the use of tile pipes as air and water tests to determine their tightness or otherwise. We had not supposed that Chicago was in a state of such sanitary and moral backwardness. It has long been one of the most elementary and well-established principles of plumbing that no tile or sewer pipe was to be tolerated within the four walls of a building occupied by human beings; and that soil and house drain pipes should be of heavy cast iron pipe to a point just inside the cellar wall and of extra heavy cast iron pipe where they pass through the wall. To plead for the use of tile pipe, therefore, is to ignore or defy good sanitation, and as there is no argument for the tile pipe except an increase of trade for the tile pipe dealers, and higher profits on cheap houses for speculative builders, moral as well as sanitary laws are also violated. Fairness to Chicago compels us to say that if its attitude in this matter evidences sanitary and moral backwardness there is reason to believe that Milwaukee, Cleveland and Cincinnati are even more backward, for we understand that each of those cities permits tile drains within houses, and we have not heard that anyone has yet made what promises to be an effective protest against the practice. Chicago, we think, is in a fair way to take a decided step forward, and roused by the cupidity and ignorance of those who object to testing tile drains, insist on the substitution of cast iron pipe. Milwaukee, Cleveland and Cincinnati might well vie with each other to see which of them could make this reform in advance of Chicago. All four of these large cities will even then be late in putting themselves in line with what has long been required in sanitarily progressive municipalities throughout the country, including towns of 10,000 and less.

Prof. Bostock Hill's recent declarations that sewage contact beds are "unscientific" and "dead," are far too sweeping, but, the world over, it is doubtless true that percolating or sprinkling filters are now more in vogue than contact beds. It should be noted that in Professor Hill's remarks, reprinted elsewhere in this issue, he really said "that contact beds as a system for sewage *resolution* [italics ours] and purification are dead." In itself this merely means that contact beds alone are insufficient; or in other words, that the organic contents must be broken down or dissolved before the sewage is applied to contact beds.

Probably few persons would deny this today, but it does not follow that because resolving tanks, be they called septic or sedimentation, are

necessary with rapid filters, therefore percolating filters are in all cases to be preferred to contact beds. Questions of grade, alone, might make percolating filters give way to contact beds in order to avoid the expense of pumping. It is only fair to note, however, that pumping sewage is so common in Great Britain as to be given less weight than it would doubtless be given here. In very cold climates the sprinklers used with percolating filters might give serious trouble through freezing. A still further possible objection to percolating filters in some localities is suggested, though unintentionally, by Professor Hill. He says that while fixed sprinklers are in general preferable to revolving ones, in the case of percolating filters, they may not always be permissible on account of the greater chance for bad odors where the sewage is sprayed into the air instead of being dropped down from revolving sprinklers. It is conceivable that even the fixed sprinklers might sometimes though probably not often give rise to offense, which would be an argument in favor of contact beds, with their sewage distributing channels at the level of the beds.

We do not raise these points to support the universal adoption of contact beds, but merely to point out that they, like percolating filters, have special advantages under certain conditions. In short, the solution of the sewage problem does not lie with any one method, but varies with numerous local factors.

As appears from the foregoing note, Professor Hill is very confident of the superiority of continuous or percolating filters over contact beds. But it may be seen from a second paper on sewage treatment, also abstracted in this issue, that in the opinion of Dr. Gilbert J. Fowler, Consulting Chemist of the Manchester Sewage Works, neither contact beds or percolating filters are all that could be desired, even when receiving sewage which has passed through a septic tank.

The basis of this opinion introduces a new factor for consideration in sewage treatment: namely, colloidal matter in sewage and sewage effluents. It is not sufficient, Dr. Fowler and his associate point out, to remove visible suspended matter from sewage, since a well clarified sewage, after standing for a time, throws down still further matter, but of colloidal origin. Some of this matter is retained in contact beds and percolating filters alike, and some goes through either class. The colloidal matter in filtrates is liable to putrefaction, in case the filtrates are not well diluted and oxidized by the waters into which they are discharged. Although the authors make no definite statement on that point, it may be inferred from their summary conclusions that as a rule the chief difficulties arising from colloidal matter pertain to the maintenance of the so-called bacteria beds rather than the ultimate disposal of the effluents. Thus, they state that experiments are being made to determine what proportion of the colloidal matter may be dealt with bacterially and what must eventually be "removed from the filtering medium for washing or screening." The whole subject, it appears, is as yet but little understood, and suggests a most interesting and useful field for investigation. The Lawrence Experiment Station of the Massachusetts State Board of Health and the Sanitary Research Laboratory and Sewage Experiment Station of the Massachusetts Institute of Technology, it would seem, might well take it up.

The main subject-matter of this and the preceding note illustrates anew how far the sewage problem still is from final solution. Most of the questions awaiting answer still center round the old sludge problem, as they have from the start. This is true notwithstanding the great claims and the lesser but notable achievements of the septic tank, which was to eliminate sludge. From the viewpoint of this note the whole matter may be summed up by quoting a sentence from Dr. Fowler's paper; a sentence not referred to in our abstract, but reserved for more prominent notice here:

> It is becoming more and more generally recognized that the real difficulty in the problem of sewage purification consists, not so much in producing a good effluent, as in finding a satisfactory method of dealing with sludge.

And "dealing with sludge," as we have seen, includes handling colloidal matter, as well as the better-known visible suspended matter. Sludge also includes matter that passes the rapid filters so much in favor to-day, and that is more in evidence in effluents from percolating filters than in that from contact beds.

We trust we shall betray no confidence if we say that Dr. Fowler informs us, in a personal letter, that his "own practice tends to 'controlled filters' of the Friern Barnet type." The Friern Barnet filters were installed years ago by that Nestor of British sanitary engineers, Baldwin Latham, and are in many respects like our well-known intermittent sand filters. It is a pleasure to be able to call atention to the fact that two such eminent sewage experts as Mr. Latham and Dr. Fowler are so much in accord with the most generally followed and successful American practice; particularly since Mr. Latham has seen and participated in the half century of British sewage development and Dr. Fowler has played no small part in the recent progress of the art of sewage treatment in Great Britain.

If we can read the signs of the times aright intermittent filtration in America will increase rather than decrease in favor. Combined with the septic tank, or in some cases with detritus tanks and screens, only, it is a simple, sure and by all odds the most efficient means of sewage treatment yet devised. It is not available in some section of this country, nor in Great Britain generally, on account of lack of local sand of suitable or of any quality, but where good sand can be found intermittent filtration should never be hastily passed by for any other method of sewage treatment depending on bacterial action in artificial beds. Finally, if we may venture an opinion, when more is known of colloidal matters, we think it may be found that they can be dealt with more effectually by intermittent sand filtration than by any other method yet in practical use.

A valuable summary of municipal work in progress and proposed at Manila, P. I., and a survey of climatic and labor conditions and of the material market in the Philippines is given elsewhere in this issue by Mr. J. F. Case, M. Am. Soc. C. E., Chief Engineer of Sewer and Water-Works Construction, Manila. Mr. Case's comments on the handling of native laborers are encouraging both to prospective contractors and to those interested in the future of the Philippine Islands. If Mr. Case's views are correct, Filipino laborers can be kept at work a larger percentage of the time than American negroes, but this requires "paternal supervision" of a broad humanitarian kind, with able foremen and special rewards for full-time or nearly full-time work.

A commendable feature of the legislative act establishing the State Water Supply Commission of New York is a provision for a report on the water supply and sewage disposal of the municipalities of the State. Special consideration is to be given to the quantity and purity of the several supplies and to the need of State systems of water supply and of sewage disposal in various sections of the Commonwealth. In accordance with the terms of this portion of the act the Commission has formulated 60 questions relating to water supply and 42 on sewerage and sewage disposal. These questions have been sent to the mayors of the 45 cities, the presidents of the 400 villages and the supervisors of the 1,200 towns of the State. The 200 water companies have also been requested to fill and return water supply forms. Through the kindness of Mr. Myron S. Falk, Assoc. M. Am. Soc. C. E., Consulting Engineer to the Commission, we have seen the inquiry blanks just mentioned. The information requested would be of great service to the people of the State and would aid in ensuring to each municipality a plentiful supply of pure and wholesome water. At first sight, the questions may stagger some city and town officials, but they ask for nothing which ought not, in its own interests, be readily available in every municipality, and since the questions were framed to cover all possible variations in local conditions many of them will be inapplicable in each city or town, thus greatly simplifying the task of making the desired returns. As the information collected is to be printed in the first annual report of the Commission it will be made generally available and therefore each municipality contributing information will have the benefit of that given by all the other contributors. It is, therefore, to the interest of all to make the several reports as complete as possible, and to do it promptly. The volume containing this information will be awaited with interest.

TUBERCULOSIS AND CAR SANITATION.

Dr. Dudley's paper on tuberculosis and railway travel, printed elsewhere in this issue, merits consideration by railway managers, sanitarians and the traveling public. Its main conclusions seem to be that the railways have fewer responsibilities and the public smaller danger on account of tubercular or "consumptive" railway travelers than is commonly supposed; and that the sanitarians have exaggerated both the responsibilities and the dangers, and thus done the railways injustice. We do not wholly agree with these conclusions.

The well-put arguments of Dr. Dudley may be summarized thus: Railways being common carriers they cannot exclude persons suffering from communicable diseases. The chief means of spreading "consumption" is the dried sputum from consumptives. The ordinary passenger spends too little time in a railway car to acquire the disease from this source, because: (1) Prolonged infection is necessary. (2) Sputum dries with difficulty and (3) when dried, is not readily pulverized, and (4) when beaten to dust and raised into the air it settles quickly. (5) The tubercle bacilli succumb quickly to light and air, both of which abound in railway cars, with their many windows and open doors. U. S. Census statistics show that railway employees have a lower death rate from tuberculosis than men in most other occupations, and Pennsylvania Relief Fund statistics show that the tuberculosis death rate is much higher among freight conductors than among passenger conductors. As to the contention that carpets, plush cushions and hangings in Pullman cars increase the danger of infection, it is stated that bacterial investigations by Dr. J. J. Kinyoun resulted in finding practically no tubercle bacilli in dust from carpets and the like, while Pennsylvania Railroad experiments indicated that flour paste (to simulate sputum) lodged on smooth wood was much more readily disseminated through the air than paste spread on carpeting and plush.

Dr. Dudley's paper will give more satisfaction to the railways than to sanitarians. Railway managers, on the one hand, will be pleased to have testimony from the eminent chemist of one of the leading railway companies in the world to the effect that the danger of contracting pulmonary tuberculosis on railway trains is less than has been believed heretofore, and that there is really no reason why plush cushions and hangings and elaborate moldings should be given up for less dust-retentive and more easily cleansed furnishings and fittings. But, on the other hand, sanitarians will certainly continue to believe that the traveling public is in sufficient danger of contracting tuberculosis and other communicable diseases to make it the duty of railway authorities to adopt generally accepted sanitary precautions against infection. And until more evidence to the contrary is available, sanitarians are not likely to accept the fact that carpets and plush retain more sputum-simulating material than do smooth surfaces as an argument in favor of the superior sanitary qualities of the former. The plea for smooth surfaces in passenger and Pullman cars is that by proper cleansing such surfaces may be kept free from disease germs of all sorts, whereas dust-retentive finishings and furnishings are not readily cleansed and are continually giving out their possible germ-laden dust contents. The experiments cited by Dr. Dudley show how much more readily smooth surfaces can be cleaned than can plush and like rough surfaces, and to that extent are an argument in favor of doing away with the rough surfaces and not, as one would infer from the paper, for retaining them. If or where it is impracticable to do away with rough surfaces the experiments indicate the need of frequent and thorough clean-

ing and disinfection of carpets, plush cushions and hangings.

The searches for tubercle bacilli in car furnishings, reported by Dr. Kinyoun, are of interest, but they would have to be repeated many times and in many sections of the country before they could be accepted as conclusive proof that railway travelers are not in danger of tubercular infection from the dust and dirt retained in and on carpets, cushions, Pullman blankets and drinking cups generally. It is particularly desirable that such bacterial studies be made in the Far West, where consumptives gather from all other parts of the country.

The mortality from tuberculosis, classified by occupations, as shown by the last U. S. Census, throws but little light upon the questions at issue, because many classes of railway employees other than those closely associated with passengers are included. They are also deficient because they are for the so-called registration areas, or for sections of the country having fairly reliable vital statistics, and thus include but a small area of the United States, and that chiefly the northeastern part of the country. The Pennsylvania Relief Fund statistics are much more to the point, but they fail to include Pullman porters, whose dangers from consumptives are far greater than those of conductors and trainmen. The Pennsylvania statistics also fail to take into account habits of living of the various classes of employees, relative exposure to the weather and other causes which predispose persons to consumption. Similar statistics for far western roads, if only they were available, might throw more and different light on the subject.

Unfortunately, we have not yet arrived at such a state of perfection in either vital statistics or bacterial analysis as will enable us to make much use of either of those sciences in determining just how dangerous consumptives are to their fellow travelers and just how infective the various kinds of car furnishings are. For the present the conservators of the public health must insist on the same general sanitary precautions for public vehicles as for public buildings, lessening or increasing those precautions in accordance with the conditions peculiar to each class of gathering place.

What we do know regarding traveling consumptives is that they are capable of scattering countless numbers of tubercle bacilli in every direction when they cough; that many of them "raise" large quantities of sputum; that in disposing of this sputum most consumptives show no consideration for their fellow travelers; that both the spray and the sputum from coughing lodge on portions of the car and its furnishings. We also know that it is the duty of railways and other common carriers so to furnish their cars and cleanse and disinfect both cars and furnishings as to reduce to a minimum the number of tubercle germs that may possibly be taken up by the clothing and hands or gain access to the mouths or nostrils of passengers.

The "prolonged exposure" theory of tubercular infection counts but little in this argument and does not materially lessen the responsibilities of the railways to safeguard their passengers against infection. In effect, the "prolonged exposure" theory is that most individuals harbor the tubercle bacillus a long time before yielding, if they ever do, to its insidious attacks. But some persons are at all times and all persons at some times very susceptible to infection, and the shortest railway journey is long enough to allow tubercle bacilli, if existing in the inevitable dust of the present day car, to gain access to either class of persons. In a man's own home, and also in his place of business, he can control to a greater or less extent both his associates and his sanitary surroundings, protecting himself one way or another from consumptives and their sputum, whether the latter be fresh or mixed with dust. He is likely to know whom to avoid and whom to coax or compel to take steps for the protection of those about him. But neither travelers nor trainmen can detect all tubercular patients, nor do much to coax or coerce most of those they do detect to shield their fellow passengers from danger of infection. It rests with railway managers, therefore, to protect the traveling public from such infection as may be conveyed by soiled bedding and by dusty carpets, hangings and cushions. This is undeniable, even though the average length of exposure per capita be short, and even though it be finally proven, as we do not feel satisfied that it has yet been, that the chances of infection during exposure are much less than has heretofore been supposed.

It is more than interesting to note in passing what is said on the subject of cleaning "railway carriages" by one of the authorities cited by Dr. Dudley as a reference source for more detailed information along the line of his own arguments. The book in question is entitled "The Prevention of Consumption." Its British author, Dr. Alfred Hillier, says:

> The cleaning of railway carriages is still grossly neglected on the lines of a large number of public companies, and it would be a great step forward in the interests and the comfort as well as the safety of passengers if all upholstered carriages were covered with a movable and washable covering, such as is already in use on some continental railways, and is even found in the railway carriages of Siberia.

Whatever theoretical deductions one may draw from Dr. Hillier's book, his instructions for the practical work of car sanitation recognize the dangers from car upholstery.

It should be borne in mind throughout the discussion of this question that many of the points at issue involve other communicable diseases than tuberculosis. The blankets of Pullman sleeping cars, in particular, are unpleasant things for the thoughtful traveler to contemplate, since they, unlike the sheets and pillow cases, cannot be washed between users and yet come in close contact with the mouths and noses of the occupants of berths, well or ill.

We have taken considerable space in which to discuss Dr. Dudley's paper and have laid chief stress upon points of dissent, because the author had so ably championed the railway interests that it seemed desirable to make a stand for the public, and also for the sanitarians who are taken to task for filling the public with unnecessary alarm. No one can rightly blame Dr. Dudley for setting up the strongest argument in favor of the railways, especially when his paper was to be presented to a body of physicians and sanitarians who could be relied upon to bring out the points on the other side. Notwithstanding the questions which we have raised regarding some of the points in the paper we take pleasure in saying that it is a noteworthy contribution to the subject of car sanitation and that, barring its somewhat partisan character, it is by far the most scientific study of this one phase of car sanitation that has ever come to our attention.

LETTERS TO THE EDITOR.

Salt for Killing Weeds on Railway Track.

Sir: Replying to the inquiry of "R. B. K.," Pocatello, Idaho, in regard to killing weeds on railway roadbed, in your issue of Oct. 5:

I have used common salt for this purpose quite successfully, sowing the salt by hand between the rails and out to the sod line, selecting a rainy day, as the salt must dissolve to do its work. One barrel of salt will kill the weeds on a stretch of track 600 ft. long, and the cost of handling is about 20 cts. per bbl. Salt was tried on a section which was dirt ballasted, and where a heavy growth of quack grass had been cut twice with a scuffle hoe, and had again attained full growth. The grass died in four to six days after the application.

As one sectionman at $1.25 per day will cut with a scuffle hoe about 500 lin. ft. of roadbed per day and this had to be done three times each season, quite a saving was effected by the use of salt. G. H. Herrold.

Red Wing, Minn., Oct. 12, 1905.

Loose Rivets in Structural Steel Work.

Sir: In answer to "Subscriber's" questions concerning loose rivets your editorial comments leave nothing more to be said as to the dangers of "doctored" rivets and the proper attitude of engineers and inspectors toward this form of scamping work. In regard to the actual practice in even good shops, however, the answer is not so clear. In the course of a somewhat wide experience in the inspection of steelwork in many prominent eastern bridge shops, the writer does not remember to have met a superintendent who would argue, as "Subscriber" reports, that "calking" rivets was good practice or not to be condemned. On the other hand, there is no shop that I know of where calking is not practiced to some extent when the inexperience or carelessness of the inspector, if there happened to be one, can be imposed upon. This is usually done by the riveter, who often has to cut out bad rivets at his own expense, but I regret to say is too often winked at by the foreman or superintendent. Another practice, hardly less to be condemned, is that of "squeezing up" loose rivets in the power riveter. This may have a slight upsetting effect on the shank of the rivet, but can hardly make a loose rivet fill the hole, though many shop superintendents will declare it to be perfectly legitimate.

The question of what constitutes a *loose* rivet, however, is not such an easy one as it might appear to one not pretty familiar with riveted work. As a matter of fact, few rivets are perfectly tight in the hole, as can be proved by sawing through a few apparently sound ones. Loose rivets range all the way from those that can be turned with the fingers to those in which an expert touch can barely detect the faintest jar when struck with a testing hammer, while some which ring true to every test disclose scale or voids if sawed through, or may become quite loose later if subjected to shock. There can be no question, I believe, that cutting out a rivet weakens the steel to a certain extent, and the exact dividing line between a rivet that must be cut out and one that had better be left in is often a matter of nice discrimination. The best ultimate result with the conditions given, and not a theory, must be kept constantly in mind in inspecting rivets; and the probability of being able to cut out a rivet and drive a new one that will be in the end more efficient than the one under consideration should always determine a doubtful case.

Very truly yours,

Charles C. Hurlbut.

320 Fifth Ave., New York, N. Y., Oct. 10, 1905.

Sir: In the comments on the writer's letter, "Tightening Rivets by Calking or Sledging," at p. 381 of your issue of Oct. 12, you ask the question: "Can the method of heating suggested by Mr. Henning be carried out in regular practice?" In answer to this and to prove the ease with which this method can be carried out in practice permit me to state that it has been used on very much work. All that is necessary, in the field work where portable rivet furnaces are used, is to put the rivets head down in the fire; when, however, large numbers of rivets are heated in the larger shop furnace which produce uniform heating over all, the end of each rivet is dipped for an instant in a can of water, which chills the rivet sufficiently. These methods were used in much work under the care of the writer, with uniform success and entirely avoiding loose rivets.

Yours truly, Gus C. Henning.

150 Nassau St., New York, N. Y., Oct. 12, 1905.

Sir: Referring to "Subscriber's" letter in your issue of the 5th inst., I would respectfully submit the following notes:

Your very clear answers to his first two questions leave nothing further for me to say regarding them. To the third question, "Is it the custom to doctor up rivets in this fashion in the eastern structural shops?" the answer lies with the inspector largely. Of course the practice is simply dishonest. The argument of the superintendent has a familiar ring to all inspectors experienced in the ways and wiles of superintendents, both in shop and field. In my experience, however, it is only fair to say, calking is not usually resorted to in large shops for the reason that with their abundance of labor and power and ease of inspection, it costs hardly more to drive new rivets than to doctor up the old ones. In erection work, however, the case is far different and a much harder problem faces the inspector. Field driven rivets cost from 7 or 8 cts. each in some classes of heavy building work requiring little if any scaffolding, to 18 and 20 cts. where the facilities are not so great. It may be readily seen that the temptation to calk may become very great, and in fact, irresistible where the inspector is inclined to be severe and has a large amount of work to cover. On a large job of viaduct erection on which I was engaged, as high as fourteen gangs of riveters were employed for some time. With four inspectors constantly on the work, it was found impossible to entirely stop the calking of loose rivets. The men became quite expert in testing the connection and loose rivets were "doctored" before the inspector could reach them. In fact, calking reached such a science that a small tool had been devised which was admirably adapted to the purpose. The inspectors were never able to get one of these tools to serve as evidence against the erectors, though most of the gangs were provided with one.

The best way to prevent this scamp work is to mutilate loose rivets by denting the heads with the hammer as soon as detected.

In general it may be said that no work under any circumstances should be done on a rivet head after it has become black, and any calking or recupping done injures it and should cause it to be condemned whether or not the same is mentioned in the specifications.

Yours truly, R. W. How,

Chief Inspector, Atlantic Ave. Improvement.

5 Hanson Place, Brooklyn, N. Y., Oct. 11, 1905.

Notes and Queries.

A correspondent inquires "whether there is any instrument on the market that will locate Gold under the Earth," and says that if we can put him in the way of obtaining such an instrument he is quite certain that he knows where he can find gold.

We have long wanted such an instrument ourselves; but have never been able to find one. That there is a continuous demand for something of this sort would appear from a recent catalogue of a well-known dealer in engineers' instruments, which states explicitly that the company has no device whatever for locating gold.

As our correspondent's letterhead states that he is an insurance broker, we would suggest that he apply to certain of the life insurance officials who have been under investigation in New York City. Some of these highly reputable gentlemen seem to have operated instruments for securing gold which worked to a charm.

NOTES ON WORKMANSHIP IN RIVETING.

By A. J. Himes,* M. Am. Soc. C. E.

It is not worth while to talk with a man who argues that loose rivets are not objectionable. Nor is it necessary, in specifications, to go further into the detail of riveting than to require first-class workmanship although a more specific statement of what is desired might avoid an opportunity for bickering among the petty officials of the bridge companies and inexperienced inspectors. The practice of cutting out loose rivets is as firmly established as the principles of bridge design and needs no defense. At one time an inspector reported an unusually large number of loose rivets, and because he was not an experienced man, the writer visited the work. He was astounded to find the greatest number of loose rivets he had ever seen. It was plain that no attempt whatever had been made to drive the rivets tight and turning to the foreman he asked what was intended by such work. The foreman was a manly fellow and did not attempt to dodge the question, but simply said "Well, I have been puttin' up bridges on the Erie Canal for ten years and this is the first time I have seen a bridge inspected." He did not claim that loose rivets were good workmanship.

But there is much of interest in the matter of riveting and a short discussion may be of value to some of your readers.

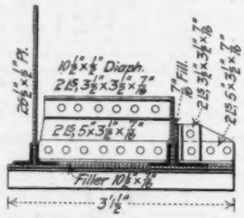
There are degrees of looseness and there is at times an honest argument among workmen as to the wisdom and necessity of cutting out rivets that are but slightly loose. A loose rivet may be detected by sound. If very loose, the impact of a hammer upon it will produce a dull click, or it may be detected by sight as a very slight motion may be observed at times when other tests would appear uncertain. If the riveted member is in such a position that water can stand around the rivet head, the very slightest vibration is readily discernible in the motion of the water. Looseness is also discovered by the sense of feeling. A sharp blow on a tight rivet will cause the hammer to rebound freely, while if the rivet it very loose, there is no recovery after impact. If a finger is laid against a rivet and touching the member containing it, a very slight vibration under the hammer can be felt if the fingers are not numb with cold or with accidental blows from the hammer. A silver quarter laid against the head of a tight rivet remains absolutely motionless when the opposite side of the rivet head is struck by a hammer, but the slightest motion of the rivet is transmitted to the silver piece and it bounds away as if the blow had been received directly.

The best way to detect looseness is to take a thin metal washer between the thumb and forefinger and hold it against the rivet head while the blow is struck with a small hammer on the opposite side of the head. The slightest jar can be readily detected in this manner. Sometimes if the first test shows the rivet tight, a second one in which the blow is struck at an angle of ninety degrees with the direction of the first blow will discover looseness, and sometimes one head may be perfectly tight when the other is loose.

Rivets can be driven absolutely tight with a hand maul as well as with a pneumatic hammer. The method employed does not excuse looseness.

The methods in vogue of inspecting rivets are very numerous. One man will try every rivet and some of them in several ways; another will try only a part of them. There is a difference in practice as to the degree of looseness which condemns a rivet, some men accepting all which do not give a jar that may be felt in the hammer handle while some condemn rivets which give the slightest vibration. When the rivets are generally tight some inspectors do not test them in every member. These matters should be left to the discretion of the responsible and intelligent inspector.

One or two per cent. of loose rivets in a member is seldom a matter of vital importance. In fact, the closest inspection does not detect all of the loose ones; an inspector can go over his own work and be sure of finding loose rivets which he has skipped. It is seldom that an inspector tries both heads of a rivet. But he should not be limited by rules. The test with a washer is as absolute as any practical test can be and if the washer is jarred the rivet is loose.



There is a purpose in testing rivets which should always be in mind but which is generally unthought of. It is to secure good workmanship. Loose rivets are largely the result of general carelessness and slovenly methods and it is the correction of these methods (or rather lack of method) which is an important aim of such inspection. If the work is not first bolted tightly together, if the burrs on the holes are not removed, if the chips and drillings are not removed from between the parts of a member before assembling or if the machine-head of the rivet is cold when driving, there is no reason to expect that the rivets will be tight. There are many other such details which only competent and intelligent men can attend to and which are essential to securing tight rivets.

One good way and perhaps the best way to correct these evils is to cut out the loose rivets. It costs money to do this, and after being compelled to cut out some loose rivets manufacturers will generally prefer to do the work in such a way as to insure tight rivets if their customers insist on them.

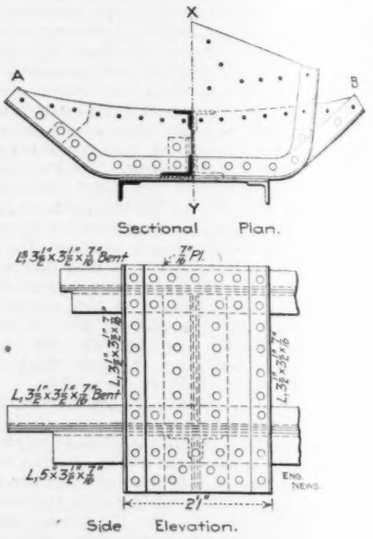
A simple illustration from the author's experience will show the good influence of rivet inspection. The workmen all find unusual difficulty in driving the end rivet in a plate-girder stiffener and plead that to cut it out if loose is likely to crack the stiffener-angle. If for this reason the inspector permits the rivet to remain in place, he soon finds that nearly all the rivets in that position are loose. The men seem to feel that they are relieved of the necessity of making an effort to get them tight. These rivets can be cut out without injury, and if it is required to be done occasionally a smaller number will be found loose.

It is easier to get rivets tight in punched work than in work that has been reamed, because the roughness of the hole afford a better grip for the rivets, but there is less certainty that the holes are filled. If a hole is not perpendicular to the surface of the member, a machine which holds on after driving cannot upset the shank of the rivet; a hole in which the component parts of the member are not truly punched presents recesses and nooks which upsetting frequently does not fill.

Recent experiments of the American Railway Engineering and Maintenance of Way Association, made at Cornell University, on riveted members in which the holes had been punched, showed that the strength of the riveting was in the friction of the rivet heads and the parts held together by the rivets rather than in the bearing value and shear of the rivets. While this element of friction has long been suspected, it was not thought that the bearing and shearing values were of so little consequence. It would be fully as interesting, and more conclusive, to have the experiments repeated upon work that has been reamed.

In order to secure good bearing the rivet must be upset so as to thoroughly fill the holes. To do this in punched work requires an accuracy of punching which we cannot always expect. That is a point which should be kept in mind by all bridge engineers.

About twenty years ago, the writer heard Mr. Kellogg say that four inches is the limit of length at which a rivet could be expected to upset and fill the hole. More recently, a very expert foreman of riveting, the best one the writer has ever known, explained very fully his experience and his conclusion that the limiting length is about four inches, and he did so without any apparent knowledge of the opinions of others upon the subject. This matter is worthy of consideration by



Bracket for Rack-Pinion Shaft of a Drawbridge, where Fastening Screws Worked Loose and were Replaced by Rivets.

all engineers who are tempted to multiply cover plates beyond the limits of usual practice.

The necessity of having the hole well filled was observed recently in the rack-pinion-shaft bracket of a drawbridge, a view of which bracket is here given. Tap bolts were used to secure the bracket to the bottom flange of the drum at the points A and B. These bolts fitted very tightly, but they were subjected to alternate stresses of considerable magnitude and after a time began to work. If the bolt holes had been perfectly filled there could have been no working. Soon after the discovery that they were loose the bolts were taken out, holes were drilled clear through the track and rivets were driven in place of the bolts. No report has yet been made of any defect having developed in the riveting.

In the repair and renewal of old bridges, reports are frequently made of large numbers of loose rivets found in the old structures. It is believed that, if the facts were known, these rivets would be found to have never properly filled the holes, and as soon as the friction had been overcome they had begun to work.

Rivets should certainly fill the holes if we are to expect durability in our structures. At the same time some allowance must be made for the imperfections of human affairs, and when there is abundant evidence that every effort is being made to do good work, there is no occasion to quibble over an *occasional* loose rivet.

THE COLLEGE EDUCATION OF THE ENGINEER.*

By William Kent.†

One of the leading engineering periodicals recently made an editorial statement to the effect that there was an over-production of college graduates in engineering. The argument was something to this effect: There are only about 16,000 practicing engineers in the United States, and the colleges are turning out something like

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3,000 men annually to fill the vacancies left by the death and the retirement of older engineers and the increasing demand caused by the growth of the country; and this crop of graduates is far too great for the country to absorb. They cannot all find positions after they graduate and many of them will be forced to abandon their career in engineering and go into some other profession or business.

This is one view of the question. The other is the actual fact that in 1903 nearly every engineering college of the country had calls for about twice as many graduates as it could furnish. In 1904, when the country was going through a temporary financial depression, some of the graduates had difficulty in finding places immediately but they all got places within two or three months. In 1905 again the demand was greater than the supply.

Why should the demand be greater than the supply? I have one statistical fact which may explain it. The U. S. Geological Survey has just issued a chart of the mineral production of the U. S. from 1895 to 1904. In the three years 1895, 1896 and 1897, when the country was recovering from the financial panic of 1893, the total value of the mineral production of the country was respectively 620, 622 and 631 millions of dollars. A revival came after 1897, and since that date the figures have been as follows: 698, 972, 1,063, 1,080, 1,280, 1,419 and 1,289 millions of dollars, the last figure, that for 1904, showing a decrease as compared with the preceding year on account of the temporary financial depression which followed the end of the "Morganization" of industries, the collapse of the ship building trust, etc. The temporary depression is past, and undoubtedly the production the present year will reach one and a half billions of dollars, or about 900 millions of dollars greater than was produced only nine years ago. One-fifth of this whole production will be pig iron; 6% will be copper; 7% gold and silver, and more than 30% will be coal, natural gas and petroleum. In order to produce this 900 millions of dollars increase in value of mineral productions in the United States in nine years, engineers have to be employed to design new mining machinery, to build new railroads, to open and develop new mines and increase the output of old ones; and after the mineral is mined to put it into the thousand various shapes it takes before it reaches the final consumer.

This increase in the demand and production of the mineral wealth of the country alone calls for an increased production of engineering graduates far beyond the number that is necessary to supply the ordinary demand caused by the retirement of older men and by the normal growth of the country. Also the increased stored wealth of the country due to the profits made out of the handling of the enormous volume of the mineral wealth of the country creates a fund which has to be spent in some way or other or it will produce no returns. If any man, or any syndicate of men, has a million dollars lying around loose he is anxious to find a means of investing it. He may loan it on bonds, but the company issuing the bonds must use it to build a railroad or factory or an electric light plant or some other structure which calls for the employment of engineers. This is the cause for the great demand for young engineers, and this is why for the last ten years the engineering colleges of the country have shown such extraordinary growth and why there is a continual call for new buildings and new equipment for the use of the ever-increasing crowds of students.

Where does the supply of young engineers come from? Principally, I should say, from the farms. The farming population of the country always tends to raise more sons than can find profitable employment on the farm. Many of these young men are forced to leave the farm in order to make a living. They hear of the wonders of electricity and of the great future there is in electrical engineering, and without knowing anything more about engineering or electricity than they know about law or medicine they flock to the schools. The number who are sons of engineers is very small for the reason that the number of engineers who are old enough to have sons of college age is as yet a small one.

It is a good thing for the engineering profession that its recruits are largely drawn from the farming population. There is no better blood in the country whether considered from the standpoint of ancestry or of present personal character. The boys are strong in body, have good health, are somewhat used to hardship and have normal minds. Such is the material which the engineering college receives. It is very raw material. Not one in ten of the boys is what can be called a brilliant student, and the college has before it the task of taking the healthy young American with more propensity for physical exercise than for mental struggle and giving him such an education in four years as will make him a tolerable member of the engineering profession and worthy to be given a subordinate position in an engineering establishment.

The average student enters the engineering college at from eighteen to twenty years of age with an ordinary high school education. In the college with which I have the honor to be connected the entrance requirements are briefly summed up in the following seven groups:

Group I. English.

II. Mathematics, including Solid Geometry and Advanced Algebra, but not including Trigonometry.

III. History (Greek, Roman and Advanced United States).

IV. Free Hand Drawing.

V. Two years of one modern language.

VI. One year of either Physics or Chemistry.

VII. One year of either Physical Geography or Geology, or Botany and Zoology.

The object of making requirements in all of these seven groups is to insure that the student has a broad foundation of general culture. The scheme omits Latin and Greek, the fine arts, logic and metaphysics, the different branches of sociology; also civics, physiology and bookkeeping, which are usually taught in the high schools. It assumes that some of these omitted subjects, such as physiology and civics, will of course have been taught in the high schools, and it leaves others, such as sociology, for the student to acquire by reading and by his contact with society during his whole lifetime. The conditions for entrance above outlined are practically the same in all the technical colleges in the country, and they have been evolved out of the experience of many years, since the first technical schools were founded.

In the Freshman year the students in all branches of engineering have practically an identical course of study. It includes elementary physics or chemistry, whichever has not been obtained in the high school; English composition and rhetoric, trigonometry and analytical geometry, descriptive geometry and shop work. Not one of these studies can be called engineering. They are merely the foundations.

In the Sophomore year chemistry is continued with qualitative and quantitative analysis. Heat and electricity are studied as branches of physics. Mathematics is continued through to calculus. Kinematics is studied, and the mathematical theory of mechanics is begun. Practical work is given in general surveying; machine drawing, blacksmith, foundry and pattern work. This sophomore course applies to mechanical and electrical engineers. The civil engineers omit the kinematics and the machine work and machine drawing, and take instead a great deal more of surveying, theory and practice, and stereotomy. Still at the end of the two years the students have obtained only the fundamentals. They have been taught practically nothing of engineering design or of modern practice outside of the machine shop and drafting room.

In the third and fourth years the mechanical and electrical engineers study machine elements, elementary steam engine, thermo-dynamics, boilers, power plants, heating and ventilating, machine design and construction; electric machinery, light and power systems; theory and practice of alternating currents, etc. The course for these two years necessarily has to be made severely theoretical in order to give the student a proper understanding of the practical work which he will get after graduation.

The course thus outlined is practically uniform throughout the higher grade of engineering colleges all over the United States, and doesn't differ essentially from that of the best schools in Europe. It is of course imperfect, as all human institutions are, but it has been developed by the most careful thought of leading engineers and educators of all countries. It will necessarily be improved but the improvement will come by slow stages.

So much for the course; what are the results? As to this there is a wide difference of opinion.

An opinion which is very commonly given is the following, recently quoted in an address by Dr. S. B. Christy, of the University of California, from the autobiography of Herbert Spencer. He mentions that in "The Speaker" for April 9, 1892, Mr. Poultney Bigelow gives an account of a conversation with Mr. Edison, the celebrated American inventor. Mr. Bigelow says:

> To my question as to where he found the best young men to train as his assistants he answered emphatically: "The college bred ones are not worth a ——! I don't know why, but they don't seem able to begin at the beginning, and give their whole heart to the work." Mr. Edison did not attempt to conceal his contempt for the college training of the present day so far as it made boys practical and fit to earn their living.

Doctor Christy, commenting on this statement, says of the words, "I don't know why, but they don't seem able to begin at the beginning and give their whole heart to the work," "Mr. Edison has put his finger with singular acuteness on the principal failing of improperly trained college students. The reason why they are not willing to begin at the beginning and give their whole heart to the work is because their education has often been so exclusively theoretical that they are filled with conceit of learning and have an inordinate idea of their untried abilities. Hence their unwillingness to begin at the beginning."

This quotation from Mr. Ediston, it will be noticed, is thirteen years old. I have no doubt that if Mr. Edison's attention were called to it to-day he would modify it considerably. I think, for instance, he might say that the college bred ones are not worth a ——! *for the first two years*, or he might say *some* of the college bred ones, for I know that Mr. Edison has had in his employ many college bred young men whom he advanced to responsible positions, and who after they left him rose to occupy the highest positions that electrical engineering offers to any man in the world.

Doctor Christy says that the college students have an inordinate idea of their untried abilities. Well, what if they have? It is only a temporary matter with them. They lose that idea, some of them in a few months and others in two or three years. The reason why they are not willing to begin at the beginning is not because their education has been so exclusively theoretical, but because they are young men of average type. They are immature and they have not that kind of wisdom which is possessed only by men of mature age. But the criticism that they don't seem able to begin at the beginning and give their whole heart to the work should not be made generally of college graduates, for a large fraction of them do begin at the beginning with "overalls and grease," as has been said; and with proper encouragement on the part of superintendents and foremen they do give their whole heart to the work.

As the result of thirty years' acquaintance with graduates in engineering I may say that I do not know of any body of young men who are more enthusiastic in their work than the young engineers are. The general statement of the worthlessness of college graduates should be modified by making it apply only to some college graduates and only to the first two or three years after graduation. If they remain worthless beyond this length of time they do not become engineers, but go into other lines of business. In the words of Professor Dugald C. Jackson in a paper read before the American Institute of Electrical Engineers in 1893:

> The old prejudice is still held against "college men" in the minds of the so-called "practical men" who had grown influential in engineering practice without having had experience of college life and training. Happily the foundation for this prejudice has ere this been destroyed through the influence of the industrial results achieved by college men. The old prejudice, so far as it now exists, has more particularly drifted into the way of criticism of the engineering schools rather than their graduates, and the character of the schools and the training they afford are subjects of eager discussion in engineering circles. It is the business of the engineering colleges to produce, not finished engineers, but young men with a great capacity for becoming engineers, the goal being obtained by the graduate only after years of development in the school of life.

One of the causes of the defects of the average engineering graduate is the unsatisfactory preparation he has had before he comes to the engineering college. In a more recent paper by Professor Jackson, read before the Central Association of Science and Mathematics Teachers, he says:

> As the pupils now come to the colleges from the secondary schools, they ordinarily possess little power of clear thinking, powers of initiative, regard for accuracy, or understanding of continuous intellectual effort. It is true that they are not yet mature in either body or mind, and too much should not be expected of them. But it is also true that their preparatory schooling has left them with a defective acquaintance with the construction of the English language and the spelling of English words, a still more defective acquaintance with French or German or a fairly good grounding in elementary Latin, a smattering of civics and history, a training in the elementary principles of arithmetic, geometry and algebra, from which the factor of accuracy in application has often been omitted, and perhaps an enthusiastic though often misguided interest in the physical sciences. . . . The unfortunate situation is perhaps a result of the inexperience of school boards, or the inexperience, inadequate compensation, or improper training of a large proportion of the teachers, or the crowding of the schools may overwork and cramp the best of teachers. . . . If the causes that contribute to allow the pupils to reach the end of the secondary school training with their originality sleeping, their normal sense of accuracy lost, and their best accomplishments in mathematics a parrot-like following of hackneyed method in familiar problems —if the causes from which these conditions spring are anchored in overcrowded classes, then it is your duty and privilege to cry aloud for more air, more breath of life, more chance to teach living individuals instead of the average of an inert class.

Mr. J. A. L. Waddell, the eminent civil engineer, who for six years of his life was also a teacher of civil engineering, makes the following complaint about engineering graduates:

> . . . not only does my firm employ constantly new graduates of technical schools from all over the United States as well as from Canada and Japan, but during my travels, which average about 50,000 miles per annum, I meet a great number of engineers, with whom I discuss such matters as technical education. Nearly all of them have complaints to make concerning the deficiencies in the training of the recent graduates of technical schools.

In regard to the defects of engineering graduates, Mr. Waddell says:

> Among the most important deficiencies noted by practicing engineers in the recent technical-school graduate are inability to express himself correctly and forcibly in either writing or speaking, lack of all ideas of system, inaccuracy in computations, ignorance of money values and economics, slovenliness in drafting, ignorance of what a drawing should contain to make it complete and serviceable, failure to understand the practical application of what he has learned in his technical course, and unacquaintance with numerous little practical things that he ought to have learned.

In regard to bad English he says:

> That the study of the English language is sadly neglected in our technical schools, nobody is likely to deny; for the English spoken by the majority of their graduates is atrocious; their letters are awkward, misspelled and ungrammatical; and their ability to write reports, specifications and contracts is practically nil.

Similar complaints are heard in England. Professor

John Perry, one of the most distinguished educators in Great Britain, Head of the Finsbury Technical Schools in London, in an address before the Engineering Section of the British Association in 1902, says:

Well-equipped schools of applied science are getting to be numerous, but I am sorry to say that only a few of the men who leave them every year are really likely to become good engineers. The most important reason for this is that the students who enter them come usually from the public schools; they cannot write English; they know nothing of English subjects; they do not care to read anything except the sporting news in the daily papers; they cannot compute; they know nothing of natural science; in fact, they are quite deficient in that kind of general education which every man ought to have.

I am not sure that such ignorant boys would not benefit more by entering works at once than by entering a great engineering school. They cannot follow the college courses of instruction at all, in spite of having passed the entrance examination by cramming. Whereas after a while they do begin to understand what goes on in a workshop; and if they have the true engineer's spirit, their workshop observation will greatly correct the faults due to stupid school work.

The "Electrical World and Engineer," of March 26, 1904, quotes Doctor Walmsley, an Englishman who visited this country to study our industrial and technical matters, as saying:

It is a matter for serious consideration whether the excessive amount of time given to manual work in the manual training schools, has not been dearly purchased at the expense of starving the time which should have been given to mental training.

The "Electrical World," commenting on these statements, says that as things are at present the higher technical institutions are busy for no inconsiderable part of the course in filling the gaps left by kindergarten foolishness of various sorts in the primary and secondary schools. They admit students at eighteen or nineteen years of age, and then spend the better part of two years in teaching them elementary English, mathematics and modern languages that have been neglected in the secondary schools to make room for nail driving, music, painting and amasculated physiology. It is of vast credit to the technical schools that in the four years' course they can turn out the material they do in spite of inefficient preparation.

The shortcomings of the technical graduates are by many of the critics attributed to the shortcomings of the technical schools themselves. Much has been written in recent years in criticism of these colleges and their methods. Dr. Walmsley is quoted as stating that many conversations with American manufacturers brought out as the most general criticism that in many cases the training is too superficial and too apt to overload the student with a large and confused assortment of facts instead of training him in principles, this being in large measure due to attempts to deal in too much detail with a crowd of subjects, especially in the last year of the course. The strongest critics of the schools are the leading educators themselves. Prof. Perry, in the article already referred to, says:

I know of nothing worse than that an engineering student should be taught mathematics or physics or chemistry by men who are ignorant of engineering, and yet nothing is more common in colleges of applied science. . . . Mathematics and physics and chemistry are usually taught in water-tight compartments, as if they had no connection with another. In an engineering college this is particularly bad. Every subject ought to be taught through illustrations from the professional work in which a student is to be engaged. . . . One most important fact to be borne in mind is that efficient teachers cannot be obtained at such poor salaries as are now given. An efficient laborer is worthy of his hire; an inefficient laborer is not worthy of any hire, however small. Again, there is a necessity for three times as many teachers as are usually provided in England. The average man is in future to be really educated. This means very much more personal attention and from thoughtful teachers. . . .

President Humphreys, of the Stevens Institute of Technology, in a paper on The Crowding of the Curriculum, read before the Society for the Promotion of Engineering Education, 1904, says:

Not only are the courses in our best technical colleges becoming crowded at the expense of efficiency, but I am strongly of the opinion that the same criticism applies to the preparatory and other schools. . . . Thoroughness and power to do has been sacrificed to a wrong conception of breadth. The introduction of fads has resulted in superficiality. There is a limit to the powers of absorption of the young mind, and I believe that in our elementary schools we have reached and passed the limit. . . . I advise those professors in our technical schools, who have not yet done so, to test their students of the higher classes in the fundamental work required for admission. . . . The failure of these students is due to two causes. First, they never have been thoroughly trained, owing to the crowding of the courses in the schools; second, what they have thus partially learned has often been crowded out or blurred over due to the crowding of the college course. In both school and college they have been so hurried from subject to subject that they have been unable to get that grasp of any subject which only comes from the opportunity to rest on it and apply it. . . . At present there is in many colleges too much independent work by the several departments. No one department should be allowed to add or change its requirements without full consideration of the course as a whole. The work of each department should be made to reinforce the work of every other department.

Another reason why the engineering graduates of many colleges are not as well educated as they should be is the overcrowding of the schools and the coming in of students in greater number than can properly be accommodated with the facilities offered. Just before the death of Professor Thurston, the late Director of Sibley College, in 1903, he made an appeal to the trustees, in which he says:

The present situation in Sibley College, regarding the need of an extension of space and facilities for teaching, is one of the gravest import.

The present facilities in Sibley College are reasonably adequate for the proper instruction of six to seven hundred students in all branches. . . . At the present time the number of students registered in Sibley College is a little over 950. . . . In shop-work the pressure has been so great that large numbers of students who have had some previous training have been passed up, simply to make room for those who have had no such training, and for whom, therefore, space must in some way be made. Under normal conditions the students thus passed up would profit greatly by further training in shop-work methods. Even with these measures of relief the numbers remaining are so great that it has been found almost impossible to make the needed adjustment of sections and hours, and in several cases men have been forced to wait some considerable length of time before a place could be found for them.

In Free Hand Drawing the sections number from 30 to 40 already, and are entirely too large for the best work on the part of the instructor. . . . In Experimental Engineering the same general conditions exist, and it has been found necessary to make laboratory assignments by threes instead of by twos as we should consider most desirable. . . . Throughout the other departments of the college the condition is but little better, and it is not too much to say that the quality of our instruction is menaced by reason of the existing overcrowded condition.

Among the several remedies proposed by different writers for the overcrowding of the technical colleges and for the insufficient preparation of the students who enter them is that of inducing as many students as possible to get some practical experience in a machine shop or other engineering establishment before coming to college. It will be many years, however, before any large fraction of the students of an engineering college can be induced to take this step.

Mr. C. J. H. Woodbury, in a lecture delivered at Sibley College in 1901, said:

A question which has often been discussed among the friends of technical instruction asks which should come first, the teaching in the school, or the practical experience in the mill or shop? The best opinions on the subject seem to agree that there should be an alternation, and that technical instruction should be prefaced by a sufficient amount of practical experience to give a purpose to the work of the student and to impress upon him the necessity of a further knowledge of the subject to which he proposes to devote himself for an occupation.

On this subject the present speaker, in a lecture at Sibley College in 1903, said:

If I were to plan a course of preparatory instruction leading to a student's entering an engineering college at the age of 19 and graduating at 23 with the degree of civil, mechanical or electrical engineer, I would give him as broad a training as possible in the preparatory school, qualifying him to enter either the philosophical or scientific course of the Liberal Arts College of the University at 17 years of age. I would then send him, not to the Liberal Arts College, but into a machine shop, where he would have to work ten hours a day for one year. Here he would get a taste of the kind of experience which every engineer must get, sooner or later. He would get there some knowledge of the world of industry, of the methods of handling men, of the value of time. He would learn there that engineering is not only the science and art of utilizing the forces of nature for the benefit of man, as Tredgold defined it, but also that it is the art of overcoming the resistances of nature, including human nature. He would learn something of the kinds of human nature with which he will have to deal in later life. He would get physical and mental strength. Above all he would "find himself," as Kipling expresses it, and learn whether or not he had made a mistake in deciding to become an engineer. If all candidates for entrance into an engineering college were compelled to take this preliminary year in the shop, perhaps 10 or 20% of them would discover before the year ended that they were not adapted to become engineers, a fact which without the shop they might not discover until after they had graduated from the college and entered practical life. This shop training, for the 80 or 90% who find by it that they have the natural capacity to become engineers, would be of great value to them in their subsequent college course. It has been the general experience of teachers of engineering that those boys who have had some experience in a shop make the best engineering students.

The most numerous critics both of the college graduate and of the college itself are generally those with the least experience and least knowledge of the subject. The man that says "I know that college graduates are no good because I have had experience with them," probably has had experience only with one or two men who had just graduated; and the one who criticizes the technical colleges for giving the student too superficial an education and crowding him with facts instead of training him in principles probably does not know what the schools are really doing.

Probably no body of men welcomes criticism as cordially as the heads of departments in the leading technical schools. There is a society for the promotion of engineering education which has existed for the last twelve years and now has enrolled about 400 members; the great majority of them professors in technical schools but about 50 of them are engineers in practice who are not teachers, and this society practically exists for the very purpose of criticizing the methods of engineering education and for finding ways to improve it. Practically every national and every local engineering society has at one time or another discussed the subject of technical education; and the technical and trade papers of the country are continually giving advice to the colleges. Statistics are constantly being compiled to show the progress of different colleges and compare the one with another. The leading technical educators of the country are constantly on the lookout for new ideas; they travel and read and discuss the subject nearest their hearts whenever there is opportunity, and if the technical colleges come far short of their ideals, and of the still higher ideals which many editors would impose on them, it is not from any lack of will on the part of those in charge of the colleges to make innovations and improvements. The trouble is that the colleges themselves are limited by conditions which are at present beyond their control.

Whatever may be the shortcomings of the technical schools, the fact remains that they are turning out a large body of men every year, a considerable fraction of whom find their way in the short space of ten or fifteen years into the higher ranks of the profession where they become employers of the younger graduates. A larger fraction remain in subordinate positions while some find more lucrative positions outside of the profession. The percentage of failures is probably as low as that of any other profession and these failures are not due to the schools but to the men themselves.

The chief trouble with the schools and the chief complaint with regard to them is not concerning the small fraction who by reason of exceptional ability rise rapidly to positions of distinction, nor concerning the small fraction that are total failures, but it relates to that very large fraction who in the first year or two after graduation are great disappointments to many employers. The shortcomings of these young men are various and have all been referred to at great length above, but it may be well here to summarize their causes, real or alleged:

(1) The nature of the boy himself, immature, careless, happy-go-lucky, possibly indolent. All of these defects may be cured within a year or two after graduation.

(2) The imperfect training he has had in the preparatory school. This is gradually being improved.

(3) The insufficient length of the course—four years—in which to take a poorly prepared boy and turn him out with the knowledge and experience which many employers think he ought to have. This cannot be remedied. A boy had better spend four years in getting a partial education in a college, then two years in a shop, than to spend six years in a college and then arrive at the shop too late in life to be willing to begin at the bottom.

(4) Wrong methods of training in the engineering courses. Too much theory, too little theory. Too much practice, too little practice. All these objections are made by various critics. If the courses are not what they ought to be, they are being improved as fast as possible.

(5) Lack of qualifications of teachers and instructors.

(6) Insufficient laboratory equipment.

(7) Too large classes.

The three last named causes of poor performance in the technical colleges are no doubt true of many of them. They are due not to lack of knowledge on the part of the managing officials of the colleges as to what the college should be, but solely to lack of funds. Much of this lack of funds is due to the exceedingly rapid growth of the schools themselves. The number of students tends to increase at a faster rate than the endowments. There are two remedies for this lack of funds. One, more endowments; the other, the increase of tuition fees. The most of the engineering colleges have before them four alternatives.

(1) To limit strictly the number of students which can be admitted.

(2) To increase the endowments.

(3) To increase the tuition fees.

(4) To diminish the efficiency of the work. It is to be hoped that no college will choose the last of these alternatives. If it does, it will not only deservedly lose its prestige but will be doing a wrong to the students who enter its walls. The high school graduate who enters any high grade engineering college to-day has a right to expect that that college will furnish him the best opportunities to obtain an engineering education that the world has to offer and this is just what every college should do everything in its power to accomplish. As President Humphrey says:

. . . No matter what the progress in science and engineering, it will take four years of honest work in our best engineering colleges to prepare our men to properly appreciate the progress in these departments. The theories included in our elementary work have to be amended from time to time, but this does not add to the burdens of the course—these are only substitutions. . . . . But no matter what we may thus do in the way of substitutes, we cannot reasonably expect to turn out thoroughly trained engineers in four years, or five years, or six years, or seven years. . . . . Independent of the question of the time to be devoted to undergraduate work, there is something the student must get outside of the college walls. He has much to learn through actual experience in the world of work. He must through experience learn to do. . . . . .

The national and local engineering societies and the individual members of these societies, nearly if not quite a majority of whom are themselves graduates of engineering colleges, have in the past been of great assistance to the colleges through their numerous papers and discussions on engineering education, through their willingness to employ the recent graduate with all his deficiencies, and many of them by actual contributions of funds

for buildings and equipment. This good service of practicing engineers is bound to continue and the result will be a constant growth and improvement of the colleges.

I conclude with the following words of Professor Thurston, at the Engineering Congress of 1893:

The profession of modern engineering exacts from its members a more extended preparation and a more arduous professional course, than are commanded to-day by the schools of either law or medicine, and this fact, if there were no other corroboration of the conclusion, has fully established the engineer in his position as a member of a profession and of a learned profession. . . . . Upon the thorough education of our engineers depends very largely the future progress of the nation.

THE INFERIORITY OF CANALS AS A MEANS OF FREIGHT TRANSPORT.*

By Daniel Bellet.

Much to the surprise of the writer, a movement in favor of the development of traffic by inland waterways has of late been manifest in Great Britain. Many complaints have been made that the railway rates are not subject to the effective competition of a good canal service, and that nothing is done to extend and complete the existing system of waterways; and regret is expressed that in the earlier days of railway enterprise the rails were in some cases laid along the "right-of-way" of then existing canals. It is contended that it is a matter of first importance that not only should the waterways still in use be enlarged and improved, but also that steps should be taken to wrest from the railway companies the control they now have over many. Moreover, certain controversialists claim that new systems should be made thus giving the manufacturer the advantages of very low freights, to the assumed general benefit of the community at large.

The writer will not raise the question as to whether it would not be really advantageous to suppress a number of the existing canals, the capital embarked in which has been lost; but he is certain that, at the present time, inland water transport is out of date, as can be shown by the example of France. All the evidence in this case establishes the inferiority of canal to rail traction. The service rendered is, indeed, far more costly than it appears at first sight; and if it is not unreasonable to preserve and improve the navigability of the existing waterways, recovering the expenditure involved from the users, it is altogether inopportune to establish new ones, which would cost at least as much as railways, whilst being incapable of rendering the same services.

The creation of the first French waterways was a very reasonable procedure, since at the time they were undertaken such canals could render the greatest services. Railways did not exist, and canal transport was very much cheaper than transport by road. It was in the sixteenth century that the idea first arose of coupling together the great rivers of France by artificial waterways, and of uniting in this way the two great seas washing the coasts of France. With this object the canal now known as the Central Canal, uniting the Loire and the Rhone, was made, and the same idea was the basis of the edict for the Canal du Languedoc, which

was to enable ships of all nations to make in a few days, by the interior of France, a trip which would otherwise involve a passage through the Straits of Gibraltar, at a loss of much time and money, and involving also the risk of piracy and shipwreck.

Whilst at the outset the establishment of canals in France, as stated, arose from a desire to avoid the risks of the open sea, military considerations were also developed by the Continental Blockade. The result was the construction of a network of canals in Brittany, intended to serve Brest, St. Malo, and Lorient. These had never much economical value, and have now less than ever, when the whole of Brittany is well provided with railways. Speaking generally, up to the time when the tolls for internal navigation were suppressed, the canals never responded to the hopes entertained by thier promoters. From the commencement of the nineteenth century, transport between the Atlantic and the Mediterranean by means of the internal waterways was commercially impossible, the freight charges being much in excess of the ocean rate. It is scarcely necessary to add that matters have not improved in this respect in later years, so that at present the wines of Cette are taken to Bordeaux by sea, in spite of the fact that the transport by river and canal is possible and toll free.

At the commencement of the nineteenth century it was, of course, quite justifiable to rank canal transport as superior to land transport. At that time transport rates were high, though it was fully realized how important it was to facilitate the interchange of goods between the different regions of France. An inquiry made about 1828 showed with great clearness that in the improvement of the means of communication was to be found the solution of all the great industrial problems. Wheeled transport on roads could not cope with the heavy and bulky goods which were precisely the articles which it was most desirable to interchange. The cost was fully 25 centimes per ton-kilometer—a figure which is still about the present-day cost of transport in the same way. On the waterways then existing it was 9 centimes, but these were only imperfectly developed. Experience in Great Britain was very similar. Here also the canals had incontestably proved their superiority to the roads, and yielded excellent dividends to their proprietors.

At the Restoration of the Bourbons, therefore, a scheme was prepared for the establishment of a vast system of canals, at a cost which was at first estimated at 1,300 million francs, though this figure was subsequently reduced to 573 millions. This system included principal waterways, secondary waterways of smaller cross-section, and finally a number of narrow local canals. This division into classes somewhat detracted from the utility of the scheme, as the existence of these narrow canals constituted a limit to the size of barge which it was commercially possible to build. In 1879 this policy was reversed; and it was decided, in principle at least, that all the canals, locks, and other structures should have uniform dimensions large enough to admit barges of relatively large size. As a consequence, the craft using the canals have gradually undergone modification, but there still exist small, narrow barges, which are a survival of the older conditions, which for the rest have not yet entirely disappeared.

The great programme drawn up under the Restoration was far from being executed in its entirety; and even now some of the schemes then projected are still unfinished, whilst others have not yet been begun. Indeed, some of the locations suggested are now occupied by railway tracks. The scheme, moreover, met a number of checks in its execution Owing to the nature of the country, the cost of establishment proved extremely high —a fact which is often forgotten by French advocates of the advantages of the canals. As matters stand, the bad pecuniary position of the French canals is not immediately in evidence, since they are now almost entirely in the hands of the State; and therefore, not having to pay a dividend, the absence of returns is not noticed by the public. In 1845, however, when a large proportion of the canals were still in the hands of private shareholders, it was not possible to ignore in this way matters of finance. The State, of which the budget was then but very modest, was only able to insure the construction of the canals by guaranteeing the interest and the sinking fund for the capital necessary. At that time tolls were demanded from boats of all kinds; but the freighters soon proclaimed these to be excessive, and demanded the gratuitous use of the waterways, which had been constructed at an enormous expense for their advantage. The State—or at least the "Administration des Ponts et Chaussées"—was at this time desirous of an almost complete suppression of these tolls, because, being proud of their work, they were anxious to prove its advantages to the nation by the density of the traffic accommodated. Obviously, the gratuitous use of the canals would tend to this; but the companies which had advanced the money for their construction had natural objections, as they desired to realize a profit from their investments. At that time, indeed, the tolls barely covered the cost of maintenance.

It was at this period when it was realized that the hopes of working the canals at a profit were illusory, that the railways made their appearance in France; and it was accordingly proposed in Parliament to suspend the construction of the canals then in process of execution, and to fill in the Canal latéral à la Garonne in order to lay in its bed, later on, the line from Bordeaux to Toulouse. This, in the writer's opinion, was a mistake, in spite of the lack of utility of the canal, since the location was not well suited to a railway. At the same time, had the policy suggested been adopted in its entirety, and the construction of new canals abandoned, France would have been the gainer by many millions of francs. As a matter of fact, a special circumstance caused a renewal of the enthusiasm for canals—viz., the invention of the movable dam, by which it was possible to render navigable at a cheap rate many natural waterways.

The regulation of rivers in this way is a much less costly matter than the excavation of artificial canals; and this method of improving and extending the systems of navigable waterways has been developed with very great success in Germany, where the conditions have been unusually favorable. This was not the case in France; yet, nevertheless, it has even there been possible, at no excessive cost, to improve in the most effective fashion the navigability of the Saône, the Seine, and the Oise. It is only in rivers, it should be remembered, that it is practicable to permit of fair speeds on the waterway. In the case of canals the wash is too great; and this fact has also restriced there the adoption of steam tow-boats. The adoption of the system, therefore, greatly improved the prospects of navigation on natural waterways; but with the assistance of the Administrations of Ponts and Chaussées the public were led to believe that the transport on the artificial waterways was equally favorably affected; and a campaign in favor of the total abolition of tolls was accordingly commenced, in order that this should lead to a substantial increase in the density of the traffic. This agitation became effective in 1880, when the tolls were finally abolished. In the meantime the State had purchased all the private undertakings, and simply written off their capital.

It is this fact which has made it possible to conceal from the public the superiority of the railways to the canals in the matter of goods transport. At the outset it was admitted that the railways would take the passenger traffic, and also goods capable of bearing heavy charges. Many people still think that the progressive lowering of railway freights has been due to the competition of the waterways, whilst actually it is mainly due to improvements in the roadbed and rolling stock. The real condition of affairs is shown by the fact that the State will not permit the railways to lower their rates below a certain minimum, in order that they may not compete too effectively with the waterways; which, it will be remembered, have been constructed or improved at an immense capital expenditure, for which no return is sought. In order to increase the supposititious competition of the canals with the railways, the State determined in the Freycinet programme to widen and deepen all canals and locks, bringing them all up to a single standard, which was to be uniform throughout France. The whole of this programme has not yet been executed, but very large sums have been expended on unprofitable enterprises. It is true that the weight of merchandise transmitted on the French waterways has largely increased, and amounted in 1903 to over 33 million tons. The average "haul" was considerable—viz., 93 miles Of the total ton-mileage, fuel was responsible for 1,409 million ton-miles, and building materials for 531 millions. It is, however, necessary to insist on the artificiality of the conditions under which this traffic is conducted; no tolls being exacted, whilst effective competition by the railway is excluded by the fixing of a minimum rate.

Reference is constantly being made to the extreme cheapness of this mode of transport, owing to the smallness of the working expenses, and of the competition between the freighters, which reduces the rate to its minimum. As stated, however, the real cost is much more than the rate charged, but is paid by the country as a whole, and not by the freighters or their clients. The high cost of constructing an artificial canal is far from being generally known, as is also that of the cost of maintenance.

France has now 4,700 kilometers of navigable waterways, satisfying the conditions considered as ideal in the programme of 1879. Of the total, 2,600 kilometers are artificial canals. Since 1879, when the tolls were suppressed, not less than 644 million francs have been spent in constructing new works, and 245 million in upkeep and repairs, the whole of which has been gratuitously presented to the freighters, together with the services of the staffs in charge of operation and maintenance. Under these conditions, the competition of the canals with the railways should certainly be effective, if possible. The cost of canal construction, as stated, has been very high. In the case of those made since 1879, which accommodate barges of a capacity of 300 tons, it averages as much as £16,000 per mile. A double-track railway of much greater capacity could probably be built for an equal sum, particularly if used for goods traffic only. It would also be shorter, as grades are permissible; whilst a canal must be built on the level.

The railway, of course, gives much the more rapid service, and this is enhanced by its relative shortness. The distance between Paris and Calais is 50% more by canal than by rail, and between other important points the advantage of the latter is seldom less than 17%. As a consequence of this and the slow speed of movement permitted, a barge working between Paris and the Department of the Nord can in practice only make five trips per year. In favorable conditions the trip can, it is true, be made in eighteen days, but in winter progress is liable to be blocked by ice, and at other times will be stopped by some part of the canal being under repair. The rate by boat is 580 francs, and by rail 6.70 francs, this difference being necessary, or the extra length of time taken would bar traffic by the canal. It should, of course, be remembered that, owing to the absence of tolls, the rate by canal is less than the actual cost of the service, the difference being made good out of the national taxes. As already stated, the railway company, in addition, has not a free hand in making its rates, all of which, before being sanctioned, must be approved by the Comité Consultatif des Chemins de Fer; and this committee will only authorize the tariff if it allows the canals a differential advantage of 20%. This is done in order to leave some raison d'être for the network of canals on which such heavy sums have been expended, and to avoid an acknowledgment of the error of judgment committed by the advisers of the State.

As matters stand at present, the construction by the Government of another new canal has been decided on, but in this instance tolls are to be charged. How long it will be possible to maintain these after construction is, however, another matter; but, certainly, the freighters who have so long been accustomed to an absence of navigation dues will feel it very hard to have to pay such dues on the new extension.

*Reprinted from "Engineering," (London), of Sept. 15.

A $161,857,000 WATER SUPPLY SCHEME has been recommended by the New York Water Supply Commission, of which Mr. J. Waldo Smith, M. Am. Soc. C. E., is Chief Engineer. The project is in general accord

with the recommendations of the Burr-Hering-Freeman report of two years ago, but naturally enough differs in details. Its main features are a 170,000,000,000-gallon reservoir (the Ashokan) in the Esopus drainage area, formed by a dam 230 ft. high and impounding water at a maximum elevation of 600 ft. above the sea; a 500,000,000-gallon aqueduct (the Catskill) 86 miles long, with branch continuations to Brooklyn and Staten Island, making a total length of 117 miles; a 40,000,000-gallon storage reservoir at Kensico, 15 miles below a proposed connection with the present Croton drainage area; a 2,000,000,000-gallon reservoir at Hill View, in Yonkers; and a 500,000,000-gallon slow sand filter plant at Scarsdale, between the Kensico and Hill View reservoirs. In addition, numerous storage reservoirs would be built in the Rondout, Schoharie and Catskill drainage areas, and connected by aqueducts with the main supply. The omission, for the present, of mountain storage equivalent to 250,000,000 gallons a day, of a portion of the filter capacity and of the pipe line to Staten Island would reduce the cost to $106,212,000. Some of the additional supply would be available for Manhattan and the Bronx as soon as connection with the Croton drainage area could be made. Pending the development outlined, Brooklyn borough should secure more water from underground sources on Long Island. The members of the commission are Messrs. J. Edward Simmons, Charles H. Chadwick and Charles A. Shaw. Messrs. Wm. H. Burr, John R Freeman and F. P. Stearns are consulting engineers to the commission. Before work can be started the plans must be approved by the Board of Estimate and Apportionment of New York City and by the New York Water Supply Commission; and, of course, detailed plans and specifications must also be drawn.

THE IMPORTS OF HYDRAULIC CEMENT into the United States in barrels of 400 lbs. are given as follows by the Bureau of Statistics, Department of Commerce and Labor:

Year ending June 30,	1900	2,307,359
	1901	1,570,539
	1902	1,036,517
	1903	2,722,134
	1904	1,460,269
	1905	990,028

In 1904, according to the "Monthly Consular and Trade Reports," August, 1905, there was shipped from the United States cement to the value of $530,216, and in 1905 to the value of $1,484,795.

ORE-CARRYING RECORDS ON THE GREAT LAKES have been broken by the U. S. Steel Corporation's new steamer "Elbert H. Gary," which has carried a cargo of 12,328 tons from Escanaba to South Chicago. The increase in size of the lake ore carriers is well shown by the rapid growth in the record cargo. For the season of 1901 it was 7,398 tons, in 1902 it was 7,576 tons, both of these records being made by barges. In 1903 the steamer 'Wm. Edenborn" carried a cargo of 7,799 tons and in 1904 the "Augustus B. Wolvin" raised this to 10,245 tons. Contracts have been awarded for two 600-ft. ore carriers which will be ready for next season's business and will still further increase the record load.

KENTUCKY ROCK ASPHALT IN PLACE OF screenings as a top dressing for macadamized roads is being tried in a number of cities. It was first used in Memphis, Tenn., by Mr. James A. Omberg, Jr., City Engineer, where some fifteen blocks of macadamized road have been finished with this material. Trial sections are also in use at Birmingham, Ala., Bowling Green, Ky., and are to be put down elsewhere. The rock asphalt is quarried from its own mines by the Wadsworth Stone & Paving Co., Bessemer Building, Pittsburg, Pa. The company states that the material contains not less than 8% of bitumen and that it should be used as follows: After shaping and rolling the roadbed as though for any other macadam or pavement, place and roll 6 ins. of 2-in. broken stone, then above this a 2-in. layer of the same sized stone, and finally spread and roll a 1-in. layer of the rock asphalt. An ordinary road roller is employed throughout and no heating of the rock asphalt is required. The advantages claimed for the rock asphalt top dressing are: greater durability of the resulting macadam, practical absence of dust, possibility of washing the gutter (without injury to the macadam) of such slight amounts of dust as may be produced, freedom from mud and slipperiness and ease of repair by patching and rolling or by complete renewal of the top dressing. The additional expense over ordinary macadam is placed by the promoters at 10 to 15 cts. per sq. yd., the extra cost of the material being partly made good by the reduced cost of rolling.

YELLOW FEVER AT NEW ORLEANS had numbered 3,820 cases and 433 deaths up to Oct. 16, with only eight new cases in the past 24 hours. On Oct. 15 there were dropped from the payrolls 115 inspectors, leaving some 400 men at work, compared with 1,276 not long before. Throughout Louisiana a general improvement in yellow fever conditions was reported.

PERSONALS.

Mr. A. Bonnyman has been appointed Chief Engineer of the Atlantic & Birmingham Ry., with headquarters at Ogiethorpe, Ga.

Mr. Leslie McHarg, formerly with the R. H. Hood Co., has incorporated a company to carry on a general contracting business, with offices at 299 Broadway, New York.

Mr. E. M. Kenly, M. Am. Soc. C. E., has been appointed General Manager of the Montana Coal & Coke Co., with headquarters at Electric, Mont., vice Mr. H. G. Merry, resigned.

Mr. Joseph Firth has been appointed an Instructor in the Department of Civil Engineering of Lehigh University. Mr. Firth is a graduate of Rensselaer Polytechnic Institute.

Mr. G. C. Kimball has been appointed Chief Engineer of the American Sheet & Tin Plate Co., succeeding Mr. Sumner B. Ely, resigned. Mr. James Peat has been appointed Assistant Chief Engineer.

Mr. F. T. Darrow has been appointed Engineer Maintenance of Way of the Nebraska District, of the Chicago, Burlington & Quincy Ry. (lines west of the Missouri River), with headquarters at Lincoln, Neb.

Mr. Robert Hawxhurst, Jr., Assoc. M. Am. Soc. C. E., late Chief Engineer of the Kohala & Hilo Ry., of Hawaii, is at present in the Philippines, examining and reporting on the proposed railway routes, for the Harriman interests.

Mr. Fred Lavis has resigned his position as Resident Engineer with the New York, Westchester & Boston R. R., to accept a position as Resident Engineer with the Pennsylvania, New York & Long Island R. R., in charge of the Bergen Hill Tunnels.

Mr. Thos. W. Cothran, for several years Chief Draftsman of the Seaboard Air Line Ry. and later with South & Western Ry., has severed his connection with the latter railway and has accepted a position with the Atlantic & Birmingham Ry., with headquarters at Ogiethorpe, Ga.

Mr Alexander Robertson, General Manager of the Terminal Railway Association of St. Louis, has tendered his resignation in order to accept the office of General Manager of the Western Maryland R. R., with headquarters at Washington, D. C. The change is to take place Oct. 31.

Mr. Henry R. Buck, Jun. Am. Soc. C. E., Assistant City Engineer of Hartford, Conn., has been appointed Chief Engineer of the Connecticut Boundary Commission. This commission will cooperate with a similar Massachusetts body in a resurvey of the boundary line between the two states.

Mr. Russell Harding, first vice-President in charge of operation of the Cincinnati, Hamilton & Dayton R. R., recently purchased by the Erie R. R., has been selected to take charge of the operation of the entire Erie system. His headquarters will be in New York City, and he will have the rank of vice-president.

Mr. Mason S. Chace, of New York, formerly President of the Crescent Shipbuilding Co., of Elizabeth, N. J., who was technical adviser at the Kawasaki shipyards in Kobe, Japan, during the war with Russia, is now on his way home. Mr. J. J. Scollan, who was Chief Engineer at the Crescent plant, has also left Kobe.

Mr. J. W. Leonard, Superintendent of Construction on the Toronto-Sudbury Branch of the Canadian Pacific Ry., has been appointed to the newly created position of Assistant General Manager of lines east of Fort William, Ont., with headquarters at Montreal. He will continue to supervise the construction of the Toronto-Sudbury line.

Mr. William C. Zimmerman, of 185 Dearborn St., Chicago, has been appointed State Architect for Illinois. He is a member of the Illinois Chapter of the American Institute of Architects, and is a Fellow of the American Institute of Architects. He is also a member of the board of examiners of architects of the state of Illinois.

Mr. Charles L. Turner for a number of years salesman and advertising manager of Char. C. Moore & Co., Engineers, 63 First St., San Francisco, Cal., has severed his connection with that company and has bought an interest in the G. W. Price Pump Co., 523 Market St., San Francisco, and will take an active part in the management of the latter company. He will also have charge of their advertising.

Obituary.

John J. Pallas, President of the Park Board and Park Commissioner for the Boroughs of Manhattan and Richmond, New York City, died suddenly Oct. 16 in that city. He was born in 1860.

Nathaniel P. Hobart, formerly connected with the American Brake Shoe & Foundry Co., died Oct. 12 at his home in East Orange, N. J., aged 58 years. He was a member of the Engineers' Club of New York and the New York Railroad Club.

Thomas F. Cogian, a superintendent of construction on the erection of the new state capitol building at Harrisburg, Pa., was killed last week as the result of a fall. He was a resident of Washington, D. C., where his remains were taken for interment.

William Hall, founder and first President of the Middlesex County Bank, the Perth Amboy Water Co., the Gas Light Co. and formerly President of the Perth Amboy Savings Institution, died Oct. 12 at his home in Perth Amboy, N. J. He was 90 years old.

F. H. Klipp, Superintendent of the Girard Boiler & Mfg. Co., of Girard, O., died Oct. 4 at Kittanning, Pa., as the result of an accident which occurred Oct. 3 while he was overlooking some work at the furnace of the Kittanning Iron & Steel Co. Mr. Klipp was born in Lewistown, O., in 1857. When but nine years old he began work as a rivet heater with the W. B. Pollock Co., Youngstown, O., remaining with this concern for ten years. In 1876 he entered the employ of the Bay State Iron Works at Erie, leaving this concern in 1880 to go to the Reeves Boiler Works, at Niles, O., as foreman. In 1884 he became one of the organizers of the Enterprise Boiler Co., of Youngstown, O. He was with this concern until 1899, when he became identified with Girard Boiler Works.

ENGINEERING SOCIETIES.

COMING MEETINGS.

MAINTENANCE OF WAY MASTER PAINTERS' ASSOCIATION.
Nov. 13, 14. Annual meeting at Cincinnati, O. Secy., H. J. Schnell, 100 William St., New York, N. Y.

ASSOCIATION OF TRANSPORTATION AND CAR ACCOUNTING OFFICERS.
Nov. 21. Annual convention at St. Louis, Mo. Secy., G. P. Conard, 24 Park Place, New York, N. Y.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Dec. 4 and 5. Annual meeting at New York, N. Y. Secy., W. H. Ross, 258 Broadway, New York, N. Y.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 5-8. Annual meeting at New York, N. Y. Secy., F. R. Hutton, 12 West 31st St., New York.

BROOKLYN ENGINEERS' CLUB.—The club's first meeting of the season was held at the club rooms, 197 Montague St., Brooklyn, N. Y., on the evening of Oct. 12. The subject for discussion was a paper on "The Relations Between the Engineering and the Architectural Professions," by Mr. D. R. Collin. Secy., Joseph Strachan.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.—The annual meeting of this society will be held at the house of the American Society of Mechanical Engineers, 12 West 31st St., New York City, on Dec. 4 and 5, 1905. It thus immediately precedes the annual meeting of the Mechanical Engineers, which begins on the evening of Tuesday, Dec. 5.

ASSOCIATION OF TRANSPORTATION AND CAR ACCOUNTING OFFICERS.—The November meeting of the association will be held at St. Louis, Mo., on Tuesday, Nov. 21, 1905. New Orleans had originally been fixed as the place for this meeting, but on account of the yellow fever epidemic a change was made to St. Louis. Reports of five technical committees will be presented, on details of the following subjects: Conducting Transportation; Car Service; Office Methods and Accounting; Per Diem; Handling Railroad Service Mail. The headquarters during the meeting will be at the Jefferson Hotel, St. Louis

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.—At the meeting of Sept. 19, 1905, a proposition to appoint a committee to confer with the Pittsburg authorities regarding a revision of the Pittsburg building laws was referred to the Board of Direction with instruction to find out what had been done in other cities and report back to the society at the November meeting. The Committee on New Quarters reported recommending that the society act alone in the matter of securing new quarters and afterwards rent to the other societies if they wish to use our rooms. The meeting instructed the committee to proceed on that basis. A paper was read by Mr. W. E. Reed on "Electric Motors and Their Applications."

At the meeting of the Chemical Section, Sept. 21, 1905, Mr. John R. Mardick read a paper on a "Cooperative Plan for Research Work." He advocated a closer bond between the manufacturers and the schools so that students could do thesis work on practical problems submitted by manufacturers. The paper called forth a good discussion. At the meeting of the Structural Section, Sept. 26, 1905, Mr. Paul Kreuzpointner read a paper descriptive of the American Society for Testing Materials. He gave a historical sketch of the development of testing engineering materials beginning with the Guilds of the Middle Ages and coming down to a statement of some of the problems now receiving consideration by the engineers of to-day.

The next month's meetings are scheduled as follows: Tuesday, Oct. 17, regular meeting of the society, paper by Mr. T. H. Johnson on "Centrifugal Fans"; Chemical Section, Thursday, Oct. 19, "The Use of Ammonium Persulphate in the Determination of Chromium in Steel," by Mr. H. E. Walters; Structural Section, Tuesday, Oct. 24, "The Uses of Steel for River Transportation," by Mr. R. J. Donovan; Mechanical Section, Tuesday, Nov. 7, informal discussion on "Bearings." Secy., F. V. McMullin, 410 Penn Ave., Pittsburg, Pa.

Vol. LIV

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